# The activation of non-target phonological knowledge in bilingual language processing Fine-grained usage and bilingual variance

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# The activation of non-target phonological knowledge in bilingual language processing: Fine-grained usage and bilingual variance

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*'Language is a living system. Every single bilingual is unique.'*

—Guillaume Thierry

*'.....people know how to talk in more or less the sense that spiders know how to spin webs. Web-spinning was not invented by some unsung spider genius and does not depend on having had the right education or on having an aptitude for architecture or the construction trades. Rather, spiders spin spider webs because they have spider brains, which give them the urge to spin and the competence to succeed.'*

—Steven Pinker

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## Abstract

This study explores whether a non-dominant first language (Punjabi) is phonologically active while performing tasks in a dominant environmental language (English) and whether activation of the non-target language extends beyond semantic representations to the lexeme. Previous research using the phoneme monitoring paradigm among balanced bilinguals is here developed and applied to a novel population permitting exploration of co-activation in a language under considerable pressure. An important element of the study is its attention to processing variance within a single bilingual population; the study assesses whether variance in bilinguals' experimental performance can be explained by their fine-grained patterns of language use. Participants completed an auditory phoneme monitoring experiment in which they monitored the phonemic content of English picture names. Distracter phonemes from the Punjabi name of the pictures formed an experimental condition. Experimental data were complemented by interviews and surveys of language usage. Analysis explored for group-level differences between bilinguals and monolinguals and for whether fine-grained differences in patterns of language use within the bilingual group (indexed through survey data) were able to account for some of the variance in bilingual processing (evident in experimental data). Group-level results were inconclusive as to whether Punjabi representations were accessed during the experimental task, but variables based on differences in Punjabi usage among bilinguals were able to account for a third of the variance in bilingual processing, in line with views of the language system as adaptive to external cues and requirements. Increased use of Punjabi in a number of usage measures was associated with the speed with which Punjabi distracter phonemes could be dismissed. The finding demonstrates that processing variance in bilinguals is not random but can arise at least partially from different usage patterns. In light of these results, the specificity and complexity of fine-grained language use is argued to be under-explored in studies of activation states. The data indicate that even small pockets of out-of-norm usage for Punjabi may be associated with shifts in processing, suggesting that low-level encounters with Punjabi in an educational, neighbourhood or professional setting could be conjectured to have potential impact on its maintenance as a cognitively active language.

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# Chapter 1. Introduction

The organisational issues and cross-fertilisations of two languages stored in a single mind have become an increasingly interesting area for psychologists and linguists over the last decades. One issue at the heart of recent enquiry has been the question of how the languages a bilingual knows interact with one another when they are being used. Put simplistically, we can speculate as to whether the bilingual's language that is not currently in use is like a summer wardrobe in the heart of winter – put away, unseen and beyond consideration for selection. Alternatively, the process may be more akin to rifling through a shared sock drawer - items in both languages mingled and briefly considered for purpose, the contents and features of each language competing and affecting one another (e.g. Costa, Miozzo, & Caramazza, 1999). In theory, languages that are processed independently of one another should not influence each other during language use (Hohenstein, Eisenberg, & Naigles, 2006). If we assume the first scenario above (a separated summer/winter wardrobe), we expect to find no evidence for the activation of the language not in use. Conversely we may assume that both languages are activated during language use, in which case the nature and location of the dual activation may be investigated: knowledge of a language consists of knowledge of phonology, morphology, syntax, semantics and pragmatics (Paradis, 2004:7), therefore the potential for cross-linguistic influence and activation theoretically exists in each of these locations.

The surge of research on co-activation over the last decade has increasingly found evidence that a bilingual's two languages are always activated and is turning its attention to the closely related issue of how, and at which levels of processing, the mind selects which language is appropriate. Bilingualism has also been found to impact on the speed of lexical access, with reduced picture naming speed repeatedly observed for bilinguals in comparison to monolinguals (e.g. Gollan,

Montoya, Fennema-Notestine, & Morris, 2005; Ivanova & Costa, 2008). However, a few issues in co-activation remain less resolved. Much of the research evidence for non-target language activation has centred on certain categories of linguistic population, focussing mainly on speakers whose languages are relatively balanced (e.g. Costa et al., 1999; Colomé, 2001; Colomé and Miozzo, 2010) and those whose dominant language remains active while a weaker language is spoken (e.g. Hermans et al., 1998; Hermans 2004; Wu and Thierry, 2012). Fewer studies have addressed the less intuitive possibility of a far less dominant language being activated to a deep level during use of a very securely dominant and stronger environmental language. Deep-level processing in the context of word production indicates the levels of mental representation which store and retrieve the phonological elements of the utterance.

Another issue less tackled in the field is processing variance. Despite a small number of new calls for more nuanced approaches (e.g. Kaushanskaya & Prior, 2015), the majority of studies continue to operationalise bilingualism only as a category, with little exploration of the processing variance this category may contain. Kroll, Bobb and Wodniecka (2006) point out that the occurrence of dual activation may vary under differing linguistic contexts, dominance patterns, individual language experiences of speakers and demands of the task. Such comments show that, even within similar speakers, variance is possible in such areas as individual experience or daily linguistic contexts and these differences are capable of impacting on language processing. This notion of processing variance within similar speakers is central to the research presented below.

This study explores two related questions within the field of bilingual language activation. First, it seeks evidence of whether activation of a non-target language proceeds beyond semantic representations to the phonological level during bilingual speech production when the non-target language is far weaker than the securely dominant environmental target language. Second, it assesses the degree to which bilingual processing patterns should be expected to be identical (or highly similar) across speakers in the same linguistic population, as opposed to varying based on finer-grained differences between speakers. To this end, interactions between non-target language activation and variegated sociolinguistic profiles are explored, considering whether variance in bilingual processing can be accounted for (even partially) by fine-grained language usage patterns.

The precise research questions of this study are as follows.

1 During language processing in a dominant language, is a less-dominant, non-target language also active at the lexeme level?

2 Does lexeme level activation in the non-target language differ among bilinguals according to sociolinguistic speaker profile (such as their usage patterns) and what are some of the relevant factors influencing processing?

These research questions are explored through a linguistic population which has been little studied in psycholinguistic research on co-activation, adult British native speakers of English as a dominant language and Punjabi as a heritage community language. This population choice permits us to assess whether a marginal and non-dominant language (Punjabi) which is under considerable pressure from a dominant environmental language remains active to a deep level when only the dominant environmental language (English) is being used. This approach may be more revealing than adding to existing evidence that non-target language activation occurs in speakers of two relatively balanced languages, or in speakers who are activating a stronger first language during use of a weaker and more much recently acquired second language. It also permits the occurrence of co-activation to be assessed in circumstances which could be considered unconducive to the prospect of maintaining a cognitively active second language.

In the British context, Punjabi can be considered as a 'squeezed' language in a number of ways. British people who speak Punjabi as an additional language receive no state education or literacy training in Punjabi, and the individual speakers in the current study have undertaken no private language training in Punjabi. Their use of Punjabi is limited in breadth to a domestic and familial sphere in which Punjabi competes with English and, on occasion, with other languages such as Urdu. Use of Punjabi outside specific domains, mainly the home and family, is not widespread and speakers feel some constraint about using Punjabi in work or educational settings. Punjabi furthermore attracts low prestige among some of its speakers (Rahman 1996) and, it would be argued here, sits in a national context attaching low value to community bilingualism.[1] The possibility, touched on only very briefly here, that in its British context Punjabi may have been influenced by English to such a

[1] See, for instance, https://theconversation.com/why-teaching-immigrant-children-english-is-turning-into-a-2015-election-issue-34930, Frank Monaghan, December 2014.

degree that it is appropriate to consider it a mixed code, adds to the picture of a language under considerable pressure from English.

This choice to focus on activation patterns in a squeezed is deliberate and strategic. Examination of co-activation of languages under pressure helps to ascertain whether co-activation is limited to certain sub-categories of bilingual, such as those whose languages are relatively balanced and those whose main language remains active while a much weaker language is spoken. Any evidence for non-target Punjabi activation is of considerable interest, suggesting that even very securely dominant languages are vulnerable to interference from second language processing. Evidence for co-activation of a far less dominant, weaker language during processing in a securely dominant environment language is markedly less expected - any evidence for non-target Punjabi activation may suggest that even very securely dominant languages are vulnerable to interference from second language processing.

Beyond the choice of a novel and under-studied population, a second important element of this study is its attention to processing variance within a single bilingual population. Rather than limit analysis to seeking group differences between bilinguals and monolinguals, the study gives high priority to assessing whether variance in bilinguals' experimental performance can be explained by their fine-grained patterns of language use. The role of fine-grained usage is argued to have an important and under-examined role in language processing. The view taken in this thesis is that the dynamic and shifting demands of a speaker's ongoing usage patterns are likely to impact upon how and when the language system activates an out-of-use language in preparation for use.

The core methodology of the current study is psycholinguistic, however the methodological approach contains some differences to typical psycholinguistic studies and is heavily influenced by theoretical insights from sociolinguistics. The study utilises an auditory phoneme monitoring paradigm to test for evidence of lexeme-level Punjabi activation while monitoring in English is performed. Traditional between-group analysis of the experimental data compared a controlled sample of bilingual speakers with a monolingual control group based on an *a priori* hypothesis. The study differs from typical psycholinguistic research designs in its restriction to a single experiment and

its in-depth analysis of processing variance within the bilingual speakers in preference to conducting repeated experiments in which analysis is limited to differences between groups.

Furthermore, though this research is a psycholinguistic examination of activation states in particular linguistic contexts, a key aspect of the approach of this study is the application of selective elements from sociolinguistic theory to enhance a psycholinguistic investigation. The psycholinguistic core study has been complemented by perspectives from sociolinguistics in that insights from sociolinguistics have informed the level of detail applied to examining fine-grained usage. A detailed questionnaire provided information on participants' Punjabi use, including use with different interlocutors over childhood and adulthood. Informed by interviews with a subset of bilingual speakers, questionnaire data was aggregated into a set of usage predictor variables. These usage variables were tested for their ability to predict variance in bilingual response time differences between experimental conditions. Two variables based on differences in Punjabi usage were able to account for a third of the variance in processing, in line with views of the language system as adaptive to external cues and requirements. Outcomes of the study raise questions for future research about whether a long-held theoretical view from sociolinguistics, Fishman's (1972) domains, could form one element of the information used by the language system to prepare for future use.

The importance accorded to detailed profiling of bilingual speakers in psycholinguistics has increased during the course of this study. Nonetheless, this study has tentatively sought to explore new relationships between long-established sociolinguistic theory and the interpretation of experimental data. The study does not produce a definitive set of sociolinguistic parameters which should be included in future psycholinguistic studies as variables, as informative as such an objective could be to the field. It does, however, extend current practice in connecting these two lenses on bilingualism.

The methodological approach taken contains both strengths and weaknesses. The main weakness of the approach is that the study does not include replication of the main experiment, or adapted follow-up experiments. (Section 5.7 suggests modulations to the experiment which would be beneficial in future research.) A counter-balancing strength of the approach taken is that it permits

examination of processing variance beneath the level of the group, which has arguably been missing from much research on bilingualism.

Some delimitations of the study should be noted. The research is methodologically focussed on behavioural rather neural data, and the review of relevant studies is consequently directly mostly to behavioural methods. It is limited to the single word and single phoneme level. This choice is not made without cognisance of the limitations of single word approaches in terms of relevance to naturalistic speech or the importance of language structure, and is motivated only by concern for managing validity; even in controlled experimental settings with a limit to single words, avoiding confounds is complex. As Section 2.2 on the choice of modality sets out, the current study makes a deliberate choice to avoid focusing on bi-literates or on bilingual reading. Lastly, the current study sits outside the field of second language acquisition; its area of interest is firmly rooted in naturalistically acquired languages, rather than in languages acquired through formal instruction.

Throughout the thesis there are references to speakers undertaking processing acts (activating, inhibiting, etc.). These references may be seen as shorthand, and are always intend to convey the language system as the agent of processing, rather than to imply that individuals themselves consciously control processing. Though there are references throughout to the *two* languages of a bilingual, this too is a shorthand for speakers with two *or more* languages.

The structure of the study is as follows. Chapter 2 outlines the theoretical frameworks informing the study, including working definitions of bilingualism, speech production, activation and relevant sociolinguistic perspectives. It goes on to review key studies relevant to the activation of non-target language lexemes before setting out the central hypotheses of the current study and the profile of the linguistic population studied. Chapter 3 details the methods used, including experiment construction, the survey of language use, recruitment and approach to statistical analysis. Chapter 4 presents results of the whole study including qualitative interview data (collected after experimental testing but analysed prior to experimental analysis) exploring fine-grained usage patterns in a sub-set of participants, aggregation of predictor variables using principal component analysis, experimental group analysis, and exploration of bilingual variance. Chapter 5 discusses findings in relation to the wider field.

Non-English words are italicised when presented in isolation in the thesis, while English words are placed in inverted commas (e.g. the Punjabi word *billi*, meaning 'cat' in English); in presenting pairs of experimental stimuli words, the target word is capitalised and neither word is italicised (such as the experimental word pair CAT/billi).

# Chapter 2. Literature Review

This chapter first provides basic definitions of bilingualism used in the field of language research and briefly describes key theories of relevance, including speech production and Activation Threshold Hypothesis. Subsequently, the core focus of the review is on evidence that activation of the non-target language proceeds below the lemma level in word production. Evidence for and against non-target activation in a number of studies is assessed. Attention is paid to the relationship between the two languages studied, in particular whether the evidence pertains to activation patterns in near-balanced bilinguals who use both languages regularly in a variety of domains, in those bilinguals who are using a weaker language, or in those using a securely dominant language. As the study aims to consider interactions between non-target language activation and variegated sociolinguistic profiles (see research question 2), the latter part of this chapter introduces relevant sociolinguistic dimensions and their methodological implications, before summarising the aims of the current study.

Section 2.1 provides the key definitions of bilingualism which have been employed in this study and gives an overview of some of the main speaker typologies found in the literature. Section 2.2 specifies the modalities involved in the study. Section 2.3 sets out some broad conceptual frameworks of activation and selection in the context of bilingual processing. Section 2.4 addresses the central focus of the chapter, activation of the non-target language below at the lexeme level. Section 2.5 presents sociolinguistic concepts to be referred to in support of Research Question 2, including language mode (Grosjean, 1998) and domain (Fishman, 1972). A summary of relevant studies is given in Section (2.6) before the aims of the current study are presented in Section (2.7).

## 2.1. Defining Bilingualism

The current study concerns what is known as individual bilingualism rather than societal bilingualism (a distinction discussed in Baetens Beardsmore, 1982). The key definition of individual bilingualism employed here is that of Grosjean (2008:10), who defines bilingualism as the 'regular use

of two or more languages,' and the bilingual speaker as 'someone who uses two or more languages in their everyday lives.' The importance of the term 'everyday', it is argued here, can perhaps be taken too literally. A bilingual who has grown up speaking a language, but then ceases to use the language except intermittently is not usually seen as having ceased to be bilingual. A key aspect of Grosjean's definition that will be returned to later is that it foregrounds usage over proficiency – a speaker becomes bilingual by virtue of regular *use* of the languages in question, rather than through absolute proficiency measures, such as monolingual-like breadth of vocabulary or mastering a specified range of grammatical structures. Usage-based definitions of bilingualism are also given by Mackey (1962) and by Weinreich (1953). Baker (2001) sees the distinction between usage and proficiency as a fundamental one and an important component of any attempt to create dimensions of bilingualism. He describes the top level dimensions of proficiency as listening, speaking, reading and writing, with thinking as a possible fifth, each of which can in turn be reduced to ever more microscopic sub-dimensions. Baker describes the key dimensions of usage as 'when, where and with whom?' which all entail an important role for domain and social context (Baker, 2001:15).

Ultimately, individual bilingualism must be seen as a spectrum, varying from the novice language learner at one end of the spectrum to the near-balanced, bi-literate bilingual at the other. There is no consensus about the extent of usage or proficiency required to meet the minimal requirements of being considered bilingual. Disagreement about appropriate delimitations of the term are thoroughly reviewed by Baetens Beardsmore (1982) and may be as minimal as the ability to produce a single meaningful utterance in the second language (Haugen, 1953, cited by Baetens Beardsmore, 1982). A vast range of possibilities exist between these two end-points of the bilingual continuum (Paradis, 2004), and, in line with Grosjean (2008), this study rejects the notion that the *ideal* bilingual speaker is one who is equally fluent in both languages, the two languages in perfect cognitive symmetry and no one language dominant. As Grosjean (2008) reminds us, the majority of the world's bilinguals present a picture of far greater complexity in the relationship between their two languages. Gardner-Chloros (1991:47), however, feels that the 'fiction' of the ideal speaker has '*in theory* been abandoned by sociolinguists' and that the modern study of linguistics contains no value judgements.

Historically, researchers have devised a very broad array of typologies of bilingual speakers, only a few of which will be touched upon here; thorough reviews of bilingual typologies can be found in Baetens Beardsmore (1982), Hamers and Blanc (2000) and Edwards (2004). The typology of perfectly balanced bilingual has already been mentioned above. Lambert (1955) conceptualised of language dominance as automaticity, i.e. equal speed of access indicates a bilingual speaker is balanced in terms of language access. Hamer and Blanc's review (2000:27) adds that: 'Equivalent competence should not be equated with the ability to use both languages for all functions and domains'. However there is some difficulty, it is argued here, in conceptualising how perfect balance can be operationalised *without* positing that use is symmetrical across both languages. Two languages with developed proficiency could not, for example, be declared equivalent if usage of one is mainly liturgical while the other is mainly domestic. Rather than see the bilingual speaker as containing two isolable language systems, each comparable to a monolingual system, Grosjean stresses a view of the bilingual language system as an integrated whole which cannot be easily split into two segments for separate study, each to be compared to a monolingual system as a check against adequacy. According to the principle of complementarity (Grosjean, 1998), a speaker's languages will not serve a symmetrical set of purposes; specific situations will be better served by one language over the other and it is 'precisely because the needs and uses of the languages are usually different that bilinguals rarely develop equal and total fluency in their languages' (1998:24). In this thesis the term 'balanced' is therefore replaced with the term '*near*-balanced'. This preference arises from the view that perfect symmetry across all possible functions and specialist domains in a speaker's two languages is a purely theoretical endpoint of a bilingual spectrum, rather than a state that can easily be exemplified with real speakers.

Measuring language dominance remains complex. It is possible to contrast approaches which stress relative proficiency patterns with those giving more attention to relative usage patterns in the two languages. A measuring system proposed by Treffers-Daller (2011) prioritises assessments of lexical diversity in each language, while a system proposed by Daller, Yildiz, de Jong, Kan and Başbağı (2011) uses vocabulary and fluency measures. Both approaches arise from the field of second language acquisition research and accord a central role in dominance to vocabulary acquisition. In contrast, the Bilingual Dominance Scale (Dunn & Fox Tree, 2009) features a range of reported measures including

usage, environment and attitude measures. The scale scores bilinguals on 12 measures and focuses on oral language usage over written proficiency, age of acquisition, self-perceived accent, reported comfort in each language, length of schooling in each language, self-reported attrition, the environmental language, language choice for performing mental calculations and a final forced choice question on which language would be relinquished if the speaker were forced to choose. A theoretically-driven scoring system accords points to each language, depending on responses, and a final score is calculated by subtracting from language score from another. The Bilingual Dominance Scale was published after data collection in the current study was underway. Areas covered by this scale overlap to an extent with those included in the current study (the survey used in the current study is presented in Section 3.4) and use of the scale, in conjunction with additional questions, would have been likely had it been available prior to data collection. Other researchers, such as Argyri and Sorace (2007), argue that dominance is best indicated by the relative *exposure* to each language. Therefore, while dominance is a key concept in the study of bilingualism and a key aspect of any characterisation of an individual bilingual, approaches to the definition, specification and measurement of this theoretical concept remain markedly varied.

Other early typologies of bilingualism ordered speakers according to cognitive organisation under three categories of compound, co-ordinate and subordinate bilingualism (Ervin & Osgood, 1954; Weinreich, 1953). In coordinate systems both concept and structure are language-specific; in compound systems concepts are shared while forms are language-specific; in subordinate systems structures in one language are attached to structures in the stronger language with no direct route to concepts through the weaker language. These categorisations do not relate to the context of acquisition but to language storage. Hamers & Blanc (2000:163) see compound and coordinate as 'two poles of a continuum on which bilinguals vary.' Other typologies relate to the chronology of acquisition in relative terms – simultaneous versus consecutive – to whether the languages are acquired early (prior to adolescence) or late (post-adolescence) and to the absolute age of acquisition (Baetens Beardsmore, 1982). A bilingual's manner of acquisition may be contrasted between that which is taught through formal instruction and that which has been acquired in natural language settings with no explicit instruction. The languages a bilingual knows are categorised as endogenous or exogamous by Hamers

& Blanc (2000), but hereafter the terms 'environmental language' and 'community language' will be preferred. The environmental language is simply the language that is predominantly used in a particular geographical setting, while a community language (used here in it its British context of use) is a non-autochthonous language spoken by members of minority groups or communities within a majority language context (National Centre for Languages definition). Hamers and Blanc (2000) review two further typologies relating to prevailing language attitudes to the languages spoken and to cultural identity of the speaker.

Beyond Hamers and Blanc's review, further typologies relating to literacy should be mentioned. Bilinguals who use literacy in only one of their languages will hereafter be referred to as monoliterate bilinguals, in contrast to bilinguals who are bi-literate and possibly also bi-scriptal (able to use two different orthographic codes). Setting aside all debate about innateness, no linguist would argue that the acquisition of literacy is biologically specified in the same way that might be argued for oral language, and it is also likely that more of the world's bilinguals use literacy in just one of their languages than in each of them (though global data to confirm this is not available). These distinctions are important to the current study and underpin the deliberate decision to explore language processing through monoliterate bilinguals.

In defining typologies of bilingualism, including those typologies which are in part cognitive, an important question to ask is whether bilinguals in fact present a unique type of language processing at all in relation to monolinguals. Paradis (2004) postulates that neither the acquisition of a second language nor the degree of mastery (proficiency) are likely to impact upon the organisation of language within the brain or processing. Paradis goes on to indicate that this is true in the restricted sense that *new* processing components are not needed for a second language, or for its increasing proficiency (even if existing neural structures are differently utilised by bilinguals). Paradis (2004) also argues that monolingual speakers switch and suffer interference in a similar manner to bilinguals, citing paraphrasing, switching between registers and accommodations to different interlocutors as examples. Bilinguals may not, according to such a view, necessarily present a unique example of language organisation, but of a particular use of the same language architecture used by monolingual speakers (i.e. what changes is 'not the organization but its contents,' Paradis suggests, 2004:190). In such a view,

processing differences between monolinguals and bilinguals would be formulated as a difference characterised by degree or strategy rather than processing structure. Research, particularly from neuroscience, may prove this proposal to be erroneous in the coming decades, and it is included here as a possibility rather than a component of the theoretical approach.

Kroll and colleagues (2012:254) view bilinguals as impressive but 'not special.' Psycholinguistics, they argue, does not concern itself about bilinguals in order to learn about particular linguistic populations, but because they are 'the model subjects of study for psycholinguists who wish to understand the full richness of the architecture of the language system and the processes that support language use and the interface between language and cognition' (2012:245). Such a view also proposes that bilinguals do not present a unique form of processing, but reveal the workings of human language processing more generally.

## 2.2. **Modality Choice: Production and Perception**

This section sets out the motivations for the modality choice of the current study. Selecting a modality from which to investigate co-activation is not a trivial aspect of research design and no assumptions are made that activation patterns in one modality will be the same as in another (see Kroll et al.'s comments on directional activation flows across modalities further below in this sub-section).

Theoretically, both the perceived speech of others and a speaker's own intention to produce speech may potentially result in activation of the non-intended language. According to models of perception, such as Cohort Theory (Marslen-Wilson & Tyler, 1980), an incoming speech stream activates a cohort of lexical items that share the first few segments. As more of the speech stream is heard, the cohort becomes smaller until the appropriate item can be selected. It is possible to speculate that a speech stream could, on occasion, activate a cross-language cohort of items. However, it is argued in this thesis that, while the bottom-up processes involved in an incoming auditory speech stream could contain triggers for the activation of the non-target language, the speech stream and a context of spontaneous discourse will equally contain the required sources of disambiguation. Utterances requiring disambiguation due to co-activation could theoretically be resolved based on multiple cues. A selection of theoretical examples of such resolution is suggested below.

a. Pragmatic constraints may disambiguate on the basis that the language-ambiguous utterance is pragmatically untenable in the current situation. For example, an English conversation in which a younger English-Punjabi student appears to hear the honorific prefix suffix 'ji' from an older English monolingual teacher, the ambiguity is resolved both by the unlikelihood of the monolingual speaker using a South Asian honorific at all and the fact that such an honorific would not be applicable to the their socially stratified relationship.

b. The phonetic environment in which lexical competitors occur may resolve short-lived language ambiguity. For instance a stressed syllable with initial /p/ might be disambiguated by the quantity of aspiration, where the two languages apply aspiration differently. Competing items such as Hindi *pak* (meaning 'pure' or 'clean') and English 'park' could be decided by fine phonetic detail such as the presence or absence of aspiration after the consonant-initial plosive and by vowel quality and length.

c. Ambiguous stretches of speech may be disambiguated by prosodic features such as stress or boundary placement. Stress placement can disambiguate words with similar or identical segments but differing stress placement, as in /ˈpɜsən/ (person) and /pəˈsʊənə/ (persona). A semantically improbable but not impossible example relating to boundary placement in monolingual speech follows. A distracted listener hears, 'He felt the bird and remained on his shoulders' from a speaker actually intending to convey 'He felt the burden remained on his shoulders.' This phonemic stream is possibly identical given that 'and' has a weak form, /ən/, which corresponds with the final syllable of 'burden':

/hɪ fɛlt ðə bɛːdən rɪmeɪnd ɒn hɪz ʃəʊldəz/

One means by which prosody could disambiguate the two alternative interpretations would be the placement of an intonation boundary after /bɛːdən/, exemplifying the claim that utterances which are different only in respect to intonation may, as a result, vary in meaning (O'Connor and Arnold, 1961).

d. Finally, cross-language competitors may also be ruled out by the syntactic environment. For example in the utterance 'It was quite…' the modifier might give rise to the expectation of a following adjective. Were the adjective 'believable' to follow, the potential cross-language

competition in situations of code-switching from phonetically similar Punjabi 'billi' (cat) would be disambiguated by virtue of the word class.

In short, speech perception might both initiate and resolve dual activation. Where perception is (at least partially) a bottom-up process in which the target language is quickly detectable from the input, speech production on the other hand is a top-down, conceptually-driven process that maps thoughts onto lexical items (Levelt, 1993). It might be speculated that an intention to speak could be somewhat less influenced by external inducements to activate both languages while assembling the utterance. Following this argument, evidence for dual activation which arises from speech production may be more indicative of a general processing tendency towards dual activation. In line with this view, Kroll argues that word production presents a maximal opportunity to interrogate activation; whereas in word recognition the speaker is not in control of the input, in production the speaker initiates the utterance and could be expected to effectively eliminate the non-target language (Kroll et al., 2012). This argument is echoed by Spalek, Hoshino, Wu, Damian and Thierry (2014) who find non-selective language access in bilinguals to be counter-intuitive given that the speaker controls the process. Colomé and Miozzo (2010:97) maintain that evidence for dual activation in word production 'amounts to the demonstration of a fairly deep form of lexical access, including all the stages up to phonological retrieval.' In spite of the proviso that production and perception processes must both be managed in conversational contexts (e.g. Levelt, 1999, Scott, McGettigan & Eisner, 2009), these arguments for the enhanced insights available from studies in word production are accepted by the author of the current study.

Modality choice has consequences for the directional flow of activation through mental levels of representation. As Kroll et al. observe in a review of literature on bilingual processing (2012), the bottom-up nature of receptive modalities determines that phonological layers of representation are more salient when speech is heard or read, while the conceptually-driven, top-down nature of word production means that co-activation at the higher level of semantic access is more salient when speech is produced. This chimes with the views of Miozzo and Colomé (2010) that evidence for phonological activation in the non-target language during production amounts to evidence for deep-level lexical access in the non-target language.

Experimental studies of speech production do also necessarily need to provide a controlled inducement to speak. This inducement takes the form of an external stimulus, often an image to be named aloud. Ensuring that the external stimulus used does not itself *cause* both languages to activate (as opposed to simply providing a means of *measuring* whether activation occurs) is a potential pitfall of research in this area which will be discussed in Section 2.5.2 addressing methodological implications. In sum, while speech production is chosen as the primary modality for this study, the role of perception cannot be entirely divorced from production even in experimental settings.

The experimental paradigm employed in this study can be seen as containing separate elements of both language production and perception. Within co-activation research, phoneme monitoring and picture-word interference paradigms are usually considered measures of oral speech production, despite containing a receptive element in the form of orthographic or aural distracters[2]. Roelofs (1992) has described the four stages of mental processing brought into play during picture-word interference experiments as follows: the picture is first conceptually identified, a corresponding lemma is next selected, following which the word form is encoded, leading to articulation. With the exception of the final stage of articulation, these stages also apply to phoneme monitoring experiments. Participants are first required to look at a picture (leading to conceptual access) and mentally retrieve its name in English (lemma and lexeme retrieval). Both paradigms follow the processing route of production. For this reason, the sections below give their primary focus to speech production modalities.

It is also clear, however, that the experimental designs in both phoneme monitoring and picture-word interference studies also have a receptive element, which may be a whole written word, a grapheme, a whole auditory word, or an individual auditory phoneme, as used in the current study. These distracters are subject to separate receptive processes. Picture-word interference tasks often include orthographic distracters which initiate reading of the distracter word (despite such studies not being considered within the field of research on reading). The phoneme monitoring experiment used in this study has involved auditory presentation of phonemes and, unlike picture-word interference tasks, has required conscious monitoring of word form information contained at lexeme level, which

[2] Despite the use of use letters and words as stimuli in some of the studies reviewed, this literature review excludes literacy and orthography except for those cases where existing studies have implicated orthographic stimuli in the evidence for dual activation in word production.

must be checked against the auditory input. For this reason, some introductory remarks on the processes involved auditory speech perception are made here.

Sebastián-Gallés (2005:547) describes the process of speech perception as 'what happens in between the perception of acoustic wave and the discovery of the meaning of our words, i.e. from physical sound waves to neural patterns representing the meaning of words.' Models of speech perception therefore need to account for how listeners are able to extract information from the speech signal in the face of high level variability in the acoustic patterns for an individual word (Stevens, 2005). As well as the variability between words uttered by speakers of the same language, Clopper and Pisoni (2005) stress the reality of variation between talkers due to regional and ethnic differences; the ability of listeners to imitate such differences and make social judgement judgements based on differences is evidence that they are aware of them. Some differences are more difficult for listeners to perceive, though Flege (2002) argues that the mechanisms and processes underpinning the acquisition of new of segments remain intact over the lifespan. Sebastián-Gallés (2005:547) describes speech perception illusions, such as those occurring when speakers cannot perceive the difference between two allophonic phonemes (e.g. a Japanese speaker hearing 'road' and 'load'), when speakers perceive a non-native sound as a version of a native sound when it is not, or when speakers perceive a non-native sound as a non-speech sound.

Categories such as phoneme, word, phrase, syllable and intonation are explanatory units useful to linguists rather than being directly observable within the acoustic stream; the directly observable events are rather the movements of the articulators and the sounds which result from those movements (Sawusch, 2005). Stevens (2005) also argues that the process of extracting words from an acoustic stream does not involve a stage at which phonemes are explicitly identified. Norris, Mcqueen and Cutler (2000) suggest such identification may only occur after a word has been identified in the acoustic stream.

Stevens (2005) proposes that the phonological representation of lexical items is composed of sequences of distinctive feature bundles. Though articulatory movements appear to be a continuum, they also exhibit categorical effects. Changes to articulation limited to a particular region of articulatory space may be relatively unlikely to effect significant changes to acoustic properties. Conversely, 'when

the articulation strays outside of this region there are abrupt changes in the acoustic properties' coupled with corresponding changes to perception (Stevens, 2005: 126). Stevens (2005:125) describes the process 'by which listeners are able to extract words from running speech' as starting with an initial stage in which a peripheral auditory system used for both speech and non-speech sounds, followed by processing which is language-specific. Sufficient information about phonetic categories is gained from this analysis to 'permit access to the lexicon, resulting in a postulated word sequence.' According to Stevens (2005) there are various strategies for analysis of incoming utterances; analysis could proceed from left to right through the stream, or begin with the words which are most readily identifiable and then move segments which are less easy to identify. In bottom up processing, analysis of the acoustic stream leads to hypothesised similarities with bundles of distinctive features in the lexicon while top down processing starts with mental representations of whole words which are compared to the incoming stream (Stevens 2005).

In the current study, participants are not required to identify words within an acoustic stream. The experiment involves speakers seeing a picture and retrieving its English name (top down word retrieval), and subsequently hearing a phoneme presented 200ms after the picture. Participants must answer yes/no to indicate whether the sound they hear is part of the picture's English name. The task requires participants to hold the phoneme in working memory long enough for a decision to be reached about the correct experimental response. One experiment examining speakers' ability to hold items in phonological working memory was Joseph, Iverson, Manohar, Fox, Scott and Husain (2015). The study used a phoneme matching paradigm to test participants' capacity for auditory recall. Joseph and colleagues view typical approaches to measuring working memory recall as overly binary, involving yes/no questions about whether an item can be recalled, with no interim possibilities. They argued that the limit of a speaker's capacity to recall items can vary greatly depending on the materials employed in the task and suggest it is possible to distinguish between inability to recall an item and a lower resolution memory. In their view, working memory might not be limited in capacity to a specific, fixed number of items, and is better conceptualised as a resource that is highly limited but which can be allocated flexibly; as the load increases, each item is remembered less precisely, with no specific fixed limit.

The study employed vowels of variable length and tested participants' ability to remember one of the phonemes in the sequence. Participants were also able to use a tool which could be adjusted to recreate the vowel sound. The differential between the recreated vowel and the original was measured, which the authors considered to provide 'an index of the quality or fidelity of phonological memory representations' (Joseph et al., 2015:2025). Analysis explored how memory load (number of phonemes in a sequence) and serial order (phoneme position within a sequence) impacted upon the precision of working memory. Precision of working memory was found to reduce as memory load increased. For example, precision was 39% lower for four items than for one item. Serial position also impacted recall, with recall 19% higher for the first item in a sequence than the last item. The study linked both memory load and serial position with the precision of recall and suggested there may not be a strict capacity limit. These results suggest that the current study design may not present a problematic load to working memory as it is limited to single phoneme.

Following these introductory remarks on the broad nature of speech perception, attention now turns to speech production. The process of speech production takes a speaker on a journey from communicative intent, through decisions about the information to be included in the message, to retrieval of the individual words in the message and articulation (Levelt, 1999). This process can also be described as involving three stages: the stage of conceptualisation (choosing the concepts to be expressed), of formulation (building a representation of the syntactic and sound structure of the utterance) and of articulation (realising the utterance as speech) (Roelofs, 1992). Which concepts the system chooses to activate during production will be determined by discourse level perspectives and models of speech production begin where such perspectives end (Levelt, 1999). Once appropriate words have been retrieved and selected, the speaker prepares for articulation. The speed and accuracy with which a normal speaker is able to retrieve and produce the right word for their discourse intent given a vocabulary of as many as 30,000 words is one of the central questions of language production research (Roelofs, 1992).

The speaker uses knowledge of the syntactic properties of words (how they relate to other words in the same utterance) in the planning of the sentence, a stage called 'grammatical encoding'. These syntactic properties of the word, taken together with its semantic specification, constitute the lemma

level (Caramazza & Miozzo, 1997). Words also have phonological properties that speakers use in preparing their syllabification and prosody, a stage Levelt terms 'phonological' (Levelt, 1999). More specifically, phonological encoding has been defined as 'the process by which speakers retrieve phonemic segments for morphemes from memory and use the segments to assemble phonological representations of words to be spoken' (Roelofs & Verhoef, 2006:167).

Most models of speech production (e.g. Levelt, 1993) share a common assumption that there are layers for: (a) conceptual meaning; (b) representations at the lemma level; and (c) word form representation containing phonological representation. Strong evidence (reviewed by Caramazza & Miozzo, 1997) has been obtained by cognitive psychologists and neuropsychologists that lexical access in word production occurs in two distinct moments, the selection of a semantically and syntactically specified lexical representation (the lemma level), followed by the selection of associated phonological content (Caramazza & Miozzo, 1997), often called the lexeme or word form level (Roelofs, 1992). It should be clarified that, while a view of lexical access involving temporally distinct access to semantic and phonological stages is accepted by the author of this study, no argument is made here that access is purely serial, i.e. that access to these levels of representation proceeds in discrete, non-overlapping stages.

Studies specifically investigating the temporal separation of semantic and phonological activation models show that semantic effects occur at an earlier stage than phonological effects (Schriefers, Meyer, & Levelt, 1990). In picture-word interference tasks employing different stimulus onset asynchronies (SOAs, the temporal difference between the appearance of the distracter stimulus and the appearance of the target picture) to explore the time course of lexical access, semantic effects occur at the early SOA of -150ms but not at the later SOAs of 0ms or +150ms. Phonological effects are not found to occur at -150ms but produce a facilitation effect at later SOAs of 0ms and +150ms (Schriefers et al., 1990). The temporal separation of these different representations can be important to isolating effects at later SOAs which can be assumed to be phonological in nature.

### 2.3. **Activation and Selection**

Of crucial interest to the current study are the notions of activation and selection. The Activation Threshold Hypothesis, as outlined by Paradis (2004), is a physiological model applying to all higher

cognitive representations. Activation is not conceptualised to be limited to any particular domain or functional system, in other words is not specialised for language. The hypothesis proposes that items in memory are activated once a certain amount of positive neural impulses have reached the neural substrate of the item. Each item has an activation threshold which refers to the amount of neural impulse necessary for activation to occur. With each instance of activation, the threshold is lowered and fewer impulses are required for reactivation. With lack of use, the threshold gradually rises again and attrition may ultimately result from extended lack of use. Paradis suggests that intensive use of one language may lead to a lower activation threshold. Changes in the usage pattern of a bilingual's languages may therefore result in changes to the underlying connections that support each language. Activation is thought to spread to related items (spreading activation*),* an approach postulating 'a network of linguistic rules and units in which decisions about what unit or rule to choose are based on the activation levels of the nodes representing those units' (Dell, 1986:283). Paradis (2004) differentiates between static interference, the presence of deviant representations in one language and dynamic interference, arising from processing; the current study concerns only the latter.

Producing words may not be as simple as the most activated item winning the activation race. Some models, such as the language specific selection hypothesis put forward by Costa et al. (1999), argue a separate mechanism for selection of an item, such as that used when assembling phrases during speech and reserving slots for items from a certain word class. In this view, activation levels are not the only factor determining which words will be produced, but instead interact with some kind of attentional or control mechanism which fulfils the function of selecting items. In contrast, a model proposed by Green (1986, 1998), contends that control mechanisms are exterior to the language system and work by modulating activation levels or their thresholds.

The purpose of any attentional or control function, either within the language system or exterior to it, is to account for the important phenomena of how the bilingual speaker manages to produce speech in only one language with minimal error in the presence of co-activation. If both languages are activated and the language system has no process for delimiting selection to one language, we can expect many more cases of error. For instance, where competitor words from the non-target language are in the speaker's more dominant language or are better fitted to a certain concept or discourse function, a

language system with no means of selectively attending to one language will be unable to prevent unintended mixing. As languages are not usually unintentionally jumbled by bilingual speakers, psycholinguistic research typically seeks to account for bilingual control.

It is useful to set out these broad hypothetical scenarios for activation and control. Four contrasting processing states are presented here.

a. **Single activation.** The non-target language is simply not activated leaving activation of the remaining language to be monitored and a word selected. Languages do not co-activate, therefore strategies of selective attention or inhibition are not required. As the non-target language is not active, cross-language effects (whether facilitation or interference) should not be observed. (This view is now seldom found in the field.)

b. **Dual activation followed swiftly by inhibition**. Both languages are activated, but a mechanism of inhibition is used to significantly reduce activation of the non-target language (Green, 1986; 1998, described further below), either before activation begins or very shortly after. The attentional mechanism does not need to limit its attention to one language, as activation levels have been manipulated such that only items in the target language are able to win the race. An attentional mechanism is, however, required to instigate the decision that one language needs to be inhibited. Depending on whether dual activation has enough time to manifest itself, there may or may not be cross-language effects at an early stage, prior to inhibition.

c. **Dual activation with non-selective access.** Both languages are activated and the most activated item wins, irrespective of language. As contended above, this scenario is not considered realistic as it effectively implies large-scale, unintended mixing of the two languages (distinct from intentional code-mixing). Such a scenario is presented as one of the logical possibilities, but is not advocated in the literature.

d. **Dual activation with language-specific selection.** Both languages are activated, but the attentional mechanism limits itself to making choices in the target language (Costa et al., 1999). This mechanism exhibits excellent control in being able to focus on one language while the other is clearly active. Assuming the mechanism has awareness of the activation in the non-target language, cross-language effects should be observed and should persist.

The first of these three scenarios (a) is what Kroll and colleagues (2008) have described as an extreme switch off theory. The latter three scenarios (b-d) allow for dual activation to be resolved in different manners. A useful analogy for all four scenarios is one person (our attentional/control mechanism) with two radio sets side by side, each radio set representing a different language. In scenario (a), the first radio set is switched off and the person is able to listen openly with no interference while the second set plays. According to inhibition (b), both radios play but the person lowers the volume on the first radio so that s/he will hear only the second set. In a model such as (c), positing dual activation without language-specific selection, both sets play loudly, the listener hears a mixture of signals from both sets and is unable to differentiate between the two. In the final scenario (d), the person leaves both radio sets playing but is able to turn his/her attention to the preferred radio and attend to that radio despite interference from the noise from the first set. Attention is now turned to the two scenarios which feature most in psycholinguistic research: inhibition (b) and dual activation with language-specific selection (d).

Inhibition is most developed by Green's Inhibitory Control (IC) model (Green, 1986; 1998, described further below), though in visual word recognition also by the computational model BIA (Dijkstra & van Heuven, 2002). Green proposes that in order for a bilingual to restrict output to one language, this language must be selected and output from the non-target language must be inhibited. As Green acknowledges that all current models of bilingual processing are based on activation levels and that choosing an appropriate word requires that its activation exceeds that of competing items, Green states that inhibition must take the form either of prevention of activation in the non-intended language or some other mechanism for regulation which is 'achieved through the modification of levels of activation of language networks' (Green 1998:68). In relation to Activation Threshold Hypothesis, Green speculates that the intention to speak one language could lead to the activation threshold of the non-target language being raised. In other words, restricting output to a single language may not necessarily be achieved by a lower activation level in the target language, but the application of a raised threshold for the non-target language.

While questions remain about its functioning, evidence for inhibition is building. As reported later in the current chapter (Section 2.4) Wu and Thierry (2011) found evidence that non-target

Chinese activation occurred later than activation in the target language of English, suggesting initial inhibition of a strong L1. Other research supporting inhibition includes Meuter and Allport's (1999) study which tested whether language switching costs in oral word production would manifest larger costs for switches to the stronger language. The authors presented the 'somewhat counterintuitive' prediction that, when switching between a stronger first language and a weaker second language, the processing cost would be larger when the switch is *into* the dominant language (1999:26). Participants were presented with a list of the Arabic numerals 0-9 to name as quickly as possible in a language dictated by screen colour. Analysis revealed switch costs were greater when the direction of switch was from L2 to L1. Meuter and Allport argued for a view of inhibition of the language not in use (in accordance with views such as IC, Green, 1986, 1998) as the weaker language could only win the competition with the stronger language if the stronger language was actively suppressed. Kroll et al. (2012) also provide a brief review of support for inhibition. The author of the current study accepts the overall evidence for inhibition, with the proviso that specific hypotheses are needed for how inhibition would be manifested differently in time course in a number of language contact scenarios.

In contrast to inhibition, the language-specific selection hypothesis (Costa et al., 1999) proposes that both languages receive activation during word production. However while both are activated in parallel, a language-specific selection mechanism will consider only items in the target language for selection. Costa and colleagues' (1999) used a picture-word interference paradigm to seek evidence for language-specific selection and test whether both languages are activated at once in near-balanced Catalan-Spanish bilinguals. The proposed selection mechanism permitted both languages to be active, with selection attending only to the target language. One of Costa and colleagues' experiments tested for cross-language identity effects using the following distracter types: the name of the picture in the target language (Catalan), its translation equivalents from the non-target language (Spanish), and one unrelated word from each language. For example, a picture of a table appeared with *taula* (Catalan for 'table'), *mesa* (Spanish for 'table'), *pernil* (Catalan for 'ham') and *jamon* (Spanish for 'ham'). Each pair of target picture and accompanying distracter word was presented simultaneously i.e. at 0ms SOA. Costa and colleagues argued identity conditions to be a promising approach to testing selection mechanisms because they believed activated items in the non-target language would have a facilitating

effect in the language-specific selection view, while in a language non-specific view they would compete for selection. Two predictions were contrasted:

a. Items in both languages are activated, items in both are open for selection. *Mesa* would therefore be highly activated from both the picture and the written distracter. *Mesa* represents a competing option for selection and would therefore interfere with *taula*.
b. Items in both languages are activated, but items in only one are open for selection; selection is restricted and only the lexical nodes in Catalan are considered for selection. *Mesa* would be highly activated from both the picture and the written distracter but would not be competing for selection and would therefore simply facilitate selection of the target *taula*.

Reaction times for identical distracters (such as *mesa* or *taula* in combination with a picture of a table) were faster than for unrelated distracters, while responses for same language pairs (in which the distracter word was in the target language) were faster than for different language pairs. In the different language trials, there was a significant difference between identical and unrelated distracters, with facilitation arising from identical distracters. The authors argued that the direction of this effect, i.e. facilitation rather than interference, presented a challenge to IC.

Four broad scenarios have been introduced above (single activation, dual activation followed by inhibition, non-selective access and language-specific selection) of which it will be argued that two are inconsistent with evidence on bilingual processing. This leaves two, more plausible accounts for bilingual control: dual activation followed by inhibition (IC) and dual activation with language-specific selection. Both approaches can be said to achieve the same end, but to differ in their account of how that end is achieved. Arguably, IC implicitly recognises that unchecked dual activation leaves open the possibility for items from the non-target language to compete and win (e.g. through higher frequency or recency of use). IC resolves this through inhibition (removal or threshold-raising) of activation in the non-target language. Ambiguity about the precise mechanism of inhibition means that a period of dual activation may occur in which cross-language effects are observable, followed by inhibition in which effects would not be manifested. Similarly, Costa et al.'s (1999) language-specific selection view also implicitly acknowledges that unchecked activation with no modulation might lead to selection of non-target language items. Their approach resolves the problem by postulating that activation is free-flowing

across languages but that a mechanism restricts selection to one language. Solutions to the problem can be seen to go in different directions but arrive at an almost identical end point: selection in the intended language.

The current study cannot provide evidence for either IC or language-specific selection. While this would have been advantageous, it was not the intention of the design and is not a research question of the study. Though it is dual activation rather than the precise means of its resolution which is the main focus of the current study, it is nonetheless important to clearly acknowledge that unhampered activation without a mechanism for selecting words from the correct language would lead to far higher error rates in bilingual production and a muddling of the two languages. Activation requires resolution, which may not be as simple as the most activated item winning.

### 2.4. **Non-Target Activation beneath the Lemma**

Attention now turns to the core question of the review, whether activation of the non-target language proceeds to the lexeme level.

One study which has questioned the extension of activation in the non-target language to the lexeme level is Hermans et al. (1998). Hermans and colleagues (1998) used cross-language phonological facilitation in conjunction with semantic measures to investigate whether words from a dominant first language are activated while accessing words in a weaker second language. This was indexed through time course, with different SOAs indexing different stages of processing (see Section 2.2 on speech modality for an explanation). Two stage models of lexical access assume that lemmas, which are semantically and morphologically specified, are accessed first, hence semantically related distracters produce their interference effect at earlier SOAs such as -300ms or -150ms rather than later. As lexemes, which are phonologically specified, are accessed after lemmas, phonologically related distracters produce their effects at later SOAs such as 0ms or +150ms (Schriefers et al., 1990).

In Experiment 1 of Hermans and colleagues' (1998) study, pictures were accompanied by four types of auditory distracter word: 1) English words phonologically related to the English target, e.g. the distracter word 'mouth' with the target word 'mountain' (a within language rather than cross-language effect and not represented in Figure 1); 2) English words phonologically related to the Dutch name for the picture once translated, e.g. the distracter word 'bench' with the target word 'mountain'

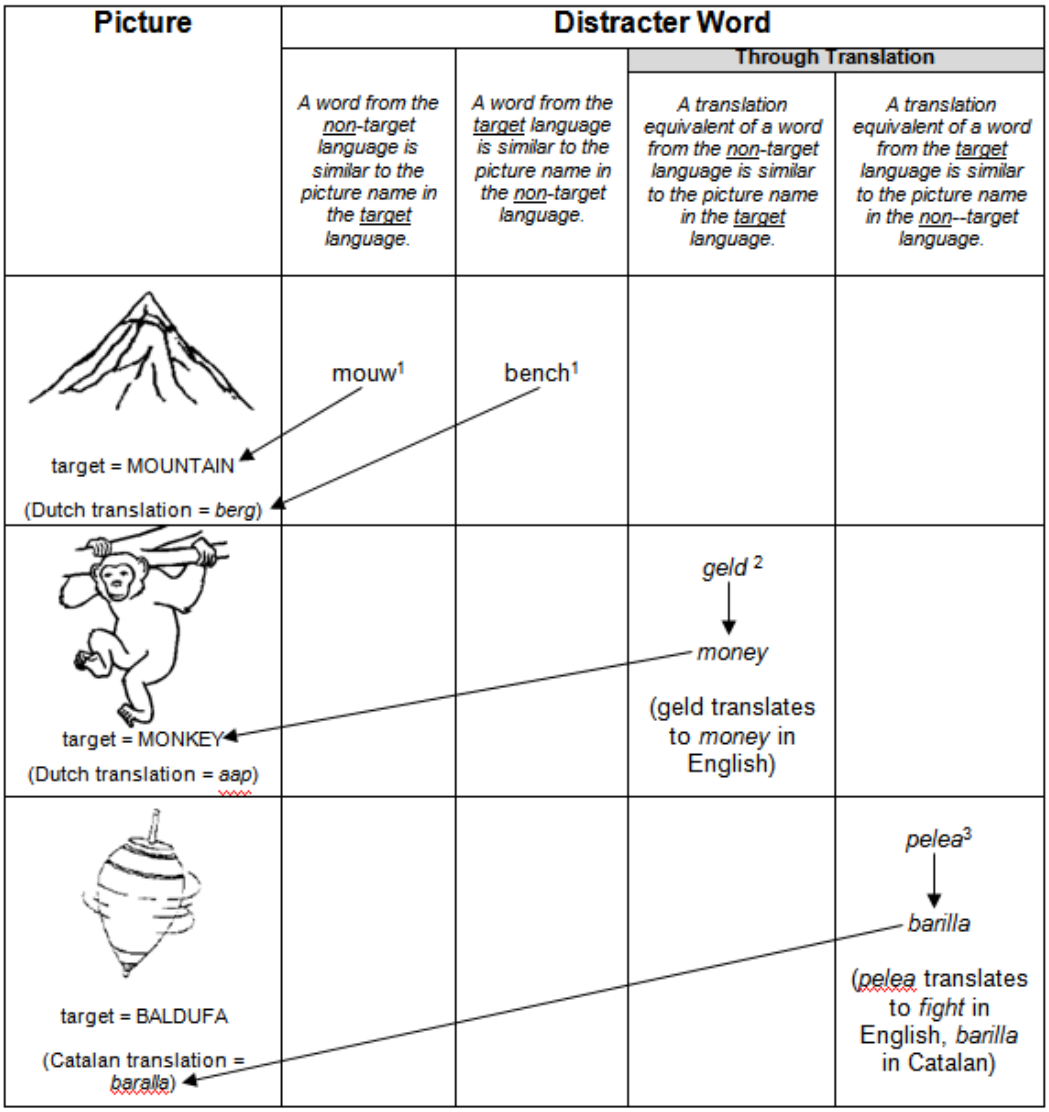
where the Dutch for 'mountain' is *berg* and thus *bench* and *berg* are phonological neighbours (called a condition); 3) English words semantically related to the picture e.g. MOUNTAIN/valley; and (4) unrelated words.

Assuming the Dutch lemma and lexeme for *berg* are active, the distracter 'bench' may produce cross-language effects for processing *berg,* hence the Phono-Dutch condition evidences whether the Dutch lexeme level receives activation from the picture. (Note that although both words are English, this is nonetheless cross-language facilitation because the potential facilitation crosses a language boundary from English 'bench' to Dutch *berg*). The study also sought to resolve the level at which the Phono-Dutch distracters would produce effects. To determine this, four SOAs were employed as a between subject factor, -300, -150, 0 and +150. The authors proposed that the Phono-Dutch distracters would lead to activation of the L1 lemma *berg* and so create semantic interference with the target mountain.

Analysis revealed within language phonological facilitation (e.g. mouth/MOUTAIN) at all SOAs, with the effect increasing in later SOAs. Semantically related distracters (e.g. gate/FENCE) produced effects at -300ms, -150ms and 0ms. The Phono-Dutch condition (bench/MOUNTAIN) was significant at 0ms but not at +150ms. At 0ms the lexeme stage of lexical access is not yet underway, while at + 150ms lexeme access is expected. This result was interpreted as indication that the Dutch lemma level was active, while the Dutch lexeme level was not**.**

A second experiment switched to Dutch distractor words that were phonologically related to the Dutch lemma (English remained the target language). Dutch was chosen over English because the authors concluded that fine phonetic detail in the auditory distracters in Experiment 1 could have provided a means of preventing activation. This consideration is of some interest - if the fine phonetic detail within aurally-presented distracters can create cross-language effects where there is phonological similarity, how great can the distance of that similarity be before the effect is lost? For instance, where a single phoneme such as /p/ can be produced with differing levels of aspiration in a bilingual's two languages (as in English and Indo-Aryan languages which employ contrastive aspiration on /p/), would aspiration levels be enough to change whether the effect occurs or not?

**Figure 1 Examples of cross-language phonological effects in picture-word interference studies**




1. Examples used in Hermans, Bongaerts, De Bot, & Schreuder (1998).
2. Example from Hermans, 2004.
3. Example used in Costa, Miozzo and Caramazza, 1999.

While the question cannot be answered here, it is in line with the suggestion in Section 2.2 that activation could theoretically be resolved by disambiguation from the phonetic environment. Hermans and colleagues (1998) used Dutch words that were similar to the Dutch lexeme of the picture name to reduce the phonetic distance. Their tentative explanation for Experiment 1's results entails that either non-target lexemes do not activate, or that the progress of activation from lemma to lexeme may be halted by contextual factors such as fine phonetic detail (see Section 2.7.4. for Hawkins' view that mental representations for words may include fine phonetic detail and Section 2.4. for comments on the capacity for phonetic environment as a source of disambiguation).

Four types of distracter were again used in Hermans and colleagues' (1998) second experiment: 1) Dutch words phonologically related to the English target e.g. mouw/MOUNTAIN; 2) Dutch words phonologically related to the Dutch name for the picture, e.g. berm/MOUNTAIN where the Dutch for mountain is *berg* and thus *berm* and *berg* are phonological neighbours which might facilitate each other (the Phono-Dutch condition); 3) Dutch words semantically related to the picture e.g. dal/MOUNTAIN where Dutch *dal* translates to English 'valley'; and (4) unrelated words.

Analysis revealed that at SOA -300ms only the Phono-Dutch condition (e.g. bench/MOUNTAIN) was significant, at -150 Phono-Dutch and the semantic condition were significant, at 0ms only the Phono-Dutch effect was significant and at +150ms the only significant effect was phonological (mouw/MOUNTAIN). Result patterns for the semantic and phonological conditions are expected, given two stage models of lexical access (e.g. Schriefers et al., 1990). The significant effects for the Phono-Dutch condition was interpreted by the authors as indication that phonological effects through translation occurred, but might be more connected to lemma level processing. The study therefore militated against the possibility of non-target phonological level activation. In this case, distracter words activated lemmas from the dominant language during picture naming in the weaker language, but it was not clear that this activation proceeded from the lemma to the lexeme level. Hermans and colleagues claimed that the Phono-Dutch effect 'at SOAs at which semantic interference is also observed can be interpreted as interference localized at the lemma level' (1998:223). In Experiment 2, where Dutch words were used as distracters, Phono-Dutch effects occurred at every level affected by semantic effects, but not at +150ms. Hermans and colleagues (1998) explained this difference in the SOAs at which semantic effects occurred in the two experiments as caused by the participants being at different points on the bilingual continuum as Experiment 2 employed words from both languages, whereas all the words in Experiment 1 were English. Hermans (2004) also interpreted their results as support for inhibition, arguing that effects for English distracter words in Experiment 1 were consistent with a view of inhibition in which some activation of the suppressed language does occur, but at a lower rate, even though it is the far stronger language.

Hermans and colleagues (1998) findings contradict those of Colomé (2001) and Colomé and Miozzo (2010), who both found evidence for activation extending to the lexeme of the non-target

language. One possible reason for Hermans and colleagues' finding may be in the nature of the design. Taking the example of a trial like MOUNTAIN-berm, in order for 'berm' to cause interference it would need to be introduced early enough to permit the following processing stages to be completed *before* the participant had accessed mental representations for the lexeme 'mountain' and begun preparing for articulation:

- analysis of the incoming acoustic stream and selection of the lexeme 'berm';
- flow of activation from the 'berm' lexeme to the 'berm' lemma;
- flow of within-language, lemma-lemma activation from 'berm' to 'berg';
- flow of activation from the 'berg' lemma to its lexeme;
- and, as a result, the activation of a cross-language competitor 'berg' to be increased due to the distracter 'berm' creating interference when the speaker articulates the target word 'mountain.'

By contrast, in a trial such as TAULA-m[3] from Colomé's (2001) study, the processing route leading to distracter effects would appear to be somewhat shorter:

- analysis of the incoming acoustic stream, /m/, which bears a degree of phonetic overlap with the onset of a cross-language competitor, 'mesa';
- as a result of the phonetic overlap between the distracter /m/ and the cross-language competitor 'mesa', the activation of 'mesa' is increased.

In the absence of a detailed examination of the bottom up time-courses involved in each of these stages in both experiments this comment is far from conclusive, but it would appear to be at least a possibility that the contradictory results might result from design differences and the length of time needed for effects to appear in the paradigm utilised by Hermans and colleagues. The author of this thesis tentatively considers the possibility that the processing route of the distracter in Hermans et al. (1998) could have involved a longer time-course than Colomé (2001), by which time the production process was already too far advanced for effects to occur.

[3] 'Taula' is Catalan for 'table,' while /m/ is the onset of the cross-language Spanish competitor 'mesa.'

Knupsky and Amrhein (2007) claimed to resolve contradictory findings between studies by Hermans and colleagues (1998) and Costa and colleagues (1999). In a within-subjects design, participants who were either English-Spanish or Spanish-English bilinguals named 192 pictures which were presented with distracters that were either phonologically related (called a direct condition, e.g. fish-fist); phonologically related through translation (a through translation condition, e.g. LEG-milk-leche); or unrelated. Results demonstrated a facilitation effect for the direct condition, but effects only occurred for the through translation condition in mixed naming (not blocked and mainly in L2 naming rather than L1). Knupsky and Amrhein (2007:221) proposed that these results clarified the contrasting results of Costa and colleagues (1999) and Hermans (2004) by demonstrating that 'through translation facilitation is sensitive to the language of the response and is more likely to occur in L2 production.' While mixed naming could in itself move speakers towards a bilingual mode, Knupsky and Amrhein's view is also consistent with the ongoing activation of a stronger or earlier acquired language during processing in a weaker second language.

A key limitation of some studies has been a tendency to employ orthographic stimuli as a measure of the phonological information encoded in the lexeme, effectively confounding orthography (which has phonological properties but which is not phonology) and phonology itself. While production studies do need to employ some kind of input stimuli (orthographic, auditory or visual) in order to induce production, the presentation of an orthographic stimulus will set in motion well-documented patterns of activation which occur in the reading of single words, as touched on above. First, assuming a grapheme-phoneme-conversion reading route, the stimulus will activate the representation of each of its letters which will in turn activate the phonemes with which they have correspondence (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). It could be argued that by activating a word in the non-response language the distracter input itself is activating the non-target language and putting the speaker into bilingual mode, rather than measuring a pre-existing activation state.

Secondly, written input produces a well-known neighbourhood effect in which words that vary by one letter of the input string and have the same letter order will be also be activated, as evidenced by robust neighbourhood effects; see, for example, Van Heuven, Dijkstra and Grainger (1998) for evidence of cross-language neighbourhood effects. We can therefore speculate that a written distracter

is likely to be activating not only its own lexeme but also the lexemes of neighbouring words, one of which may be the target itself. The problem of this effect is that it makes it difficult to isolate the source of the effect. This second point is discussed by Costa and colleagues (1999:366) who conclude that 'the extent to which each of these mechanisms contributes to the phonological effect is at present unclear'.

Costa and colleagues (1999) comment that non-words have been shown to also produce a phonological facilitation effect, suggesting that the effect does not arise from the semantic content of the distracter and that part of the cross-language identity effect reported above may originate in phonological facilitation. This implies that the presentation of any letter string will activate lexemes which are phonologically similar, in which case a phonologically related written distracter word is creating activation for all words in either language which overlap. The validity of orthographic phonological facilitation as a measure of whether both languages are activated during natural speech may therefore be questionable given that the task itself could be activating lexemes of both languages. Conversely, assuming that distracter words are read using the lexical route (Coltheart et al., 2001), it might be speculated that activation at the lexeme level is present, but that its full extent is not indexed by this paradigm.

Hoshino and Thierry (2011) explored cross-language effects through translation further. In order to avoid the problem of artefactually introducing the non-target language, they kept distracter items in the target language, looking instead at whether cross-language effects arose through the translation equivalents of the distracters. Participants were Spanish-English bilinguals naming pictures in L2 English who were instructed to ignore on screen English distracter words. Distracter words were either: semantically-related to the English target word; phonologically related to the English target word; phonologically related to the Spanish translation equivalent of the English target (i.e. through-translation); unrelated.

The authors anticipated that if distracters activated their translation equivalents in the non-target language, phonological activation would spread to the target word, a through-translation effect producing interference. The study also employed event-related potentials[4] (ERP) and predicted

[4] As described by Hull and Vaid (2005), ERP captures averaged brain potentials which are evoked by a specific cognitive event, producing component signatures comprised of peaks (positive voltage) and valleys (negative voltage) which illuminate the degree and timing of electrical activity in the brain during language processing.

observing effects at 200ms and also 400ms. Results revealed a significant main effect for distracter type. Pictures with unrelated distracters were named faster than pictures with any other type of distracter. Naming accuracy for words with semantically related distracters was significantly lower than for unrelated distracters. Accuracy for naming distracters which were phonologically related to the target word or its equivalent in the non-target language was not significantly different to accuracy for words with unrelated distracters. The behavioural results of Hermans and colleagues (1998) were therefore replicated, i.e. a slowing effect for all other distracter types, except that here within language phonological effects produced interference. ERP data revealed the interference effects to be present at 200-260 milliseconds and 350-400 milliseconds.

The authors concluded that bilinguals activate their first language while operating in a monolingual second language environment and that ERP results were consistent with activation to the lexeme level. The study was a development on Hermans and colleagues (1998) in that it eradicated the sources of potential artefact and provided further information on the time course of phonological activation, which was present at 200 milliseconds and still persisted at 350-400 milliseconds. This led the authors to further conclude that lexical selection was not achieved at the lemma level, which would have arrested the flow of activation and prevented it from reaching the phonological level.

Another paradigm which has produced some evidence that activation proceeds to the lexeme level has been cognate picture naming. Costa, Caramazza and Sebastián-Gallés (2000) used cognate and non-cognates in a picture-naming task to resolve whether activation is likely to occur at the lexeme level in the language not-in-use. The authors asked Catalan-Spanish bilinguals and Spanish monolinguals to name pictures which were either cognates or non-cognates using Spanish as a response language. Two predictions were contrasted based on discrete and cascade theories of lexical access. According to discrete theories (e.g. Levelt, Roelofs & Meyer, 2000), it is only the lemma which is selected which sends activation to its lexeme, while non-selected lemmas do not. Cascade theories of lexical access (e.g. Dell, 1986), on the other hand, allow for lemmas which are activated but not selected sending activation to lexeme level. Discrete and cascade theories can be applied to bilingual processing if the activation of the non-target language lexeme is compared to competing items in a monolingual's language system. Costa and colleagues (2000) contrasted the cascade prediction that cognates would

be named faster by bilinguals than non-cognates with a discrete prediction that cognates and non-cognates would not significantly differ in naming latencies.

Experiment 1 in Costa and colleagues' (2000) study found that cognates were answered significantly faster by bilinguals than by Spanish monolinguals. A second experiment investigated whether the effect of cognate naming would be comparable in a dominant language as compared to a second language. With Spanish as a response language, Catalan-dominant bilinguals and Spanish-dominant bilinguals both had faster naming latencies for cognates, with a larger magnitude of effect for Catalan-dominant participants (in other words, the facilitation was greater for naming a slightly weaker language). The results indicated a facilitation effect for bilinguals naming cognates. This cognate facilitation effect was mediated by response language – both dominant and non-dominant languages showed an effect, but the magnitude was greater in the less dominant language (Costa et al., 2000). Interactivity was discussed as an alternative possible explanation for the results. Interactive models (e.g. Dell, 1986) postulate a bi-directional flow of activation which can flow forward/down from the lemma level to lexeme as well as backwards/up from lexeme to lemma. Costa and colleagues (2000) gave the example of naming a picture of a cat which leads to activation of the lemmas *cat*, as well as *dog*, 'mouse' (semantically related) and *cap*, *car* (phonologically related). If these lemmas activate their lexemes, in an interactive view the activated lexemes can also send activation back up to the target *cat*. The observed cognate facilitation effect is consistent with lexeme level activation in the non-response language, though the study did not resolve whether activation follows a uni-directional or a bi-directional cascade pattern.

Cognates have been widely considered problematic stimuli for demonstrating non-artefactual language co-activation. Wu and Thierry (2011:1), for instance, argue that the presentation of cognates artefactually activates items in both languages because they contain near identical representations in each language; for this reason they suggest that 'studies involving cognates have limitations regarding result generalization.' For this reason, cognate studies are henceforth not presented in detail in this thesis.

In a key study of non-target lexeme activation, Colomé (2001) explored evidence for non-target language phonological activation in near-balanced Catalan-Spanish bilinguals using the phoneme

monitoring paradigm. The paradigm was adapted from a study by Wheeldon and Levelt (1995) in which subjects listened to English words, translated them to Dutch and pressed buttons when the translation contained a previously specified phoneme.

Phoneme monitoring directly addresses the central research of the current study in that it measures activation of lexemes in the non-target language. The task demand for participants is to monitor the target word for the presence of the phoneme presented. For instance, in an English language phoneme monitoring task with English-French bilinguals, if a picture of a house was presented with the letter m, the task would be to monitor whether the phoneme /m/ is part of the lexeme 'house' and respond in the negative. Assuming that activation occurs in the response language only, the non-response lexeme *maison* should not interfere. Where response latencies indicate that /m/ does interfere, this is interpreted as evidence for activation of the non-target language lexeme. In this paradigm, the online process of lexical access takes place while a separate task of monitoring the phoneme and making the correct response is managed.

Colomé (2001) used the phoneme monitoring task in three experiments with Catalan-Spanish bilinguals and a fourth control experiment with Spanish monolinguals. Experiment 1 contained 25 experimental drawings to be named in the target language Catalan. Each picture was presented three times for 2000ms, preceded by a letter appearing for 1000ms. The picture/phoneme pair were followed a blank screen for 1000ms. The experiment comprised three experimental conditions: a) an affirmative trial in which the letter presented did feature in the picture name (always the first syllable of the Catalan name for the picture); b) a negative trial in which the letter featured was the first syllable of the Spanish translation for the picture name; c) a negative trial in which the letter featured was part of neither the Catalan nor the Spanish name for the picture (an unrelated phoneme). Reaction times were measured from the onset of the picture up to its disappearance from the screen at which time subjects answered yes/no indicating whether the letter featured in the Catalan word for the picture. This was followed by a blank screen for 1000ms before the beginning of the subsequent trial. Participants were given the words they would have to monitor beforehand to study for ten minutes so that they did not name the wrong words.

T-tests were conducted to investigate differences between the two negative conditions (phonemes featuring in the Spanish translation versus unrelated phonemes). Analysis revealed a 41ms advantage for the unrelated phoneme over the onset of the Spanish translation indicating that it took longer to reject phonemes from the translation than phonemes which were absent from either language. Colomé concluded that activation of the non-response language lexeme was influencing subject responses.

To avoid the possibility that showing the letter first acted as a cue for retrieval of the picture name, Experiment 2 showed the pictures before the letters. Pictures were displayed for 200ms and letters for 500ms (SOA +200ms) and the number of negative and affirmative trials for each item were equated. In this experiment each picture appeared four times using the same conditions as Experiment 1 and an additional affirmative condition in which the letter presented featured as the onset of the second syllable of the Catalan word. Reaction times were measured from the appearance of the letter and subjects were given 2000ms to answer. Out-of-time answers were omitted. Results indicated that subjects took longer to reject the Spanish phoneme than the unrelated phoneme, replicating the effect of the first experiment. A third experiment repeated Experiment 2, but displayed the picture for 400ms followed by the letter which appeared for 600ms (SOA +400ms). Reaction times were measured from the appearance of the letter over a window that continued until 1400ms after its disappearance. Subjects again required a longer latency to reject the phoneme which was present in Spanish. A fourth experiment provided a monolingual control to verify that monolingual subjects would not show a significant difference in response latencies for rejecting the Spanish phoneme and the unrelated phoneme.

Colomé concluded that the study provided evidence for words in both languages being activated at once and for this activation extending to the lexeme level. While the study did not specifically measure activation at the lemma level, the author assumed that lexeme level activation would have its source in the lemma.

In discussing what the results revealed about organisation of 'the phoneme layer,' Colomé (2001:732) speculated that, as phonemes in the non-response language have been shown to influence participants' decisions, it could be the case that each phoneme has two representations, one for each

language. In such a case, Colomé argued, participants might take into account the activation of both sets. A second option put forward by Colomé was that there is a 'certain overlap in the segmental information that bilinguals store for each of their languages', especially when the languages are similar (Colomé, 2001:732). In other words, part of the segmental information is common to the two languages. Colomé urges caution in this interpretation given that an orthographic presentation was used (written letter stimuli were used to indicate the phonemes to be monitored) which might have induced participants to monitor a graphemic representation of the picture name rather than a phonological one. While even this possibility still arguably indicates that dual activation has occurred, it again points to the problems mentioned earlier with using orthographic stimuli to index phonology.

In a review of the experimental evidence for bilingual dual activation, Costa, La Heij and Navarette (2006) agreed that phoneme monitoring provided the 'most compelling evidence supporting the notion of parallel activation of the two languages of a bilingual' (Costa et al., 2006:141), but also argued that results from phoneme monitoring studies could be flawed if the phoneme presented was sending bi-directional activation to the lexical items in both languages. Suggesting that the interpretation of the results hinged on there being no effect at all of the presentation of the stimulus phoneme, Costa and colleagues (2006) proposed that the task itself could be inducing the activation of the non-response language rather than measuring it. This argument was based on the idea of a bi-directional flow of activation in which activation begins in a feedforward manner from the semantic system on to the lexical system (lemmas) to the sub-lexical system (lexemes) but can bounce from the sub-lexical back up to the lexical level (Costa et al., 2006). This interactivity could theoretically apply within one language (language-selective) or across both languages (non-selective) (Costa et al., 2006). In this view, phonemes in a phoneme monitoring study could bounce activation back up through layers of representation in just one of the subject's languages, or both. Costa and colleagues (2006) argued that even if only one language is being activated, (i.e. the semantic system confines activation to the response language) the target lexeme initiates a crossing of the language boundary by sending activation both back up the network and, importantly, across to the non-response language.

These criticisms may be somewhat problematic. Where Costa and colleagues (2006) correctly point out that the interpretation of results from phoneme monitoring hinges on the assumption that

there are no effects of presenting written phonemes, they under-specify how the effect would operate. The argument that activation of the non-response language has not occurred simultaneously implies a single activation view of lexical access (the activation of a concept arising from the picture has not sent activation to the non-response language lemma, or activation has ceased at the lemma level) and a dual activation view (bottom-up activation from the phoneme enters the lexeme level and crosses to the non-response language, artefactually activating it). Thus, the scenario entails a language system which prevents dual activation at one level, yet permits it at a lower level. Also, if activation were permitted to cross the language divide in this manner, this could still be seen to be originating within the language system itself rather being a result of the experimental paradigm, as the single letter is a feature of the target language and does not *by itself* constitute a lexical item in the non-target language.

Another way to consider the experiment problematic would be to propose that it induces dual activation because the letter single-handedly activates the non-response lexeme. Given a scenario of single activation (or activation not proceeding below the lemma level) in which the picture presented activates only the target language and not the non-response language lexeme, it is difficult to postulate how a single grapheme could be responsible for activating the contents of non-target lexicon to the extent that a robust interference effect is created. While the presentation of a graphemic string could activate items in the orthographic lexicon which match the input (Dijkstra & van Heuven, 2002), the probabilities of a single grapheme activating the particular target word are argued here to be considerably lower. If, on the other hand, both languages are activated to the lexeme level, it is possible to argue that an already activated non-response lexeme could pick up further activation from the grapheme, however this is consistent with Colomé's (2001) interpretation of the results. In short, the possibility that the phoneme monitoring effect is produced artefactually because the task itself induces dual activation appears somewhat difficult to justify. Even if bi-directional activation occurs and can cross the language divide, this is not necessarily an artefact because a single phoneme from the target language is different to a complete lexical item from the non-target language. Should activation truly be limited to one language, the possibility for a single grapheme to create a slowing effect is considered here to be quite limited.

Phoneme monitoring would also appear to have some advantages over picture-word interference tasks. In his critique of the methodologies used to study bilinguals, Grosjean (1998) introduced the notion of modes, postulating a monolingual mode in which only one language is activated, an intermediary mode in which one language is more activated but the other is somewhat activated also and a bilingual mode in which both languages are fully prepared for imminent use (described in Section 2.5.2). For studies attempting to measure whether both languages were activated, Grosjean (1998) recommended that the words from both languages should not appear within the experiment or, preferably, within the experimental environment. This means the stimuli, the instructions and all communications with participants should avoid use of the non-response language. To use both languages would, Grosjean (1998) argued, risk inducing activation of the non-response language by putting the participants into bilingual mode. In this regard, the confound risks of phoneme monitoring would appear to be significantly lower than those of picture-word interference tasks, which have utilised words from both languages as distracters (e.g. Costa et al., 1999; Hermans et al., 1998).

In contrast, the monitoring task presents no whole words and the low probability of a single grapheme activating a particular lexeme in the non-response language has been argued above. Picture-word interference tasks introduce entire words in the form of distracters which creates an opportunity for inducing the activation that is purportedly being measured. As argued above, the fact that orthographic distracters activate their own lexemes and lemmas as well as those of their orthographic neighbours is an indication that distracters create their own impact on activation levels of participants. Use of a single letter avoids this potential confound. Additionally, the phoneme monitoring task reported (Colomé, 2001) has used naming in one language and the stimuli themselves arguably contain neither language because only pictures and single letters are used. In this way the task is in line with Grosjean and colleagues' (1998) advice to avoid introducing the second language into the experiment. The phoneme monitoring paradigm was therefore selected[5] for the current study as a robust and appropriate measure for indexing whether activation occurs in both languages and specifically whether this activation proceeds to the level of phonology, the central concern of this thesis.

[5] The research design choice of phoneme monitoring was made in 2007, before a number of studies presented in this review were published. Section 7.1. discusses whether a single phoneme is capable of initiating activation of the non-target language and concludes that this is unlikely.

Other researchers have also echoed some of the cautions about use of the non-target language stated here. Wu and Thierry (2010), for instance, also contend that paradigms employing stimuli which explicitly engage both languages are not giving sufficient consideration to the role of experimental language context. Such paradigms, they argue, include picture-word interference in which words from the non-target language appear on screen, those studies employing interlingual homographs or written cognates and tasks which entail switching between languages during the experiment. These tasks may co-activate both languages even where testing ostensibly involves only one, so that language context operates as a potentially confounding variable. Disregarding the language context within which the task takes place is argued to have serious implications for the findings. Wu and Thierry (2010) propose that studies on the interactions of bilinguals' languages consider seven elements of the design, listed below:

a. whether the task requires explicit retrieval of representations in each language, or just a single language;
b. whether the experiment involves stimuli from each language, or language-ambiguous stimuli, such as cognates or interlingual homographs;
c. the level of difference between participants' two languages including orthographic transparency and phonological overlap, as language pairs which are very similar could mean that speakers theoretically co-activate more often;
d. whether the performance of bilinguals is compared through within-group analysis, which may carry a risk of carry-over or order effects, or between groups, which offers independence but arguably reduced power;
e. whether bilingual participants are asked to discuss their awareness of the monolingual/bilingual nature of the tasks at the end of the experiment;
f. other contextual elements of the design which could potentially draw the participants' attention to one language over the other, such as instruction language, the experimenter's L1 and the place in which experiments are conducted;
g. how the factors listed above interact with another.

These important questions are returned to in Chapter 5 (page 201), as part of the interpretation of the results and limitations of the current study.

It is acknowledged that researchers have echoed some of the concerns voiced by Costa, La Heij and Navarette (2006) about phoneme monitoring during the course of this study's data collection and analysis. Colomé herself later acquiesced that the source of activation in phoneme monitoring might be unclear. In Colomé and Miozzo's (2010) study, the authors concurred with Costa and colleagues' (2006) review, in which the single phoneme was argued to produce artefactual activation, as happens in picture-word interference paradigms, though no further detail was provided to specify the effect.

Rather than phoneme monitoring, Colomé and Miozzo (2010) employed a picture-picture interference task. In the task, participants viewed pairs of overlapping pictures on screen. The outline of each picture was coloured either red or green. Colour of the outline provided a cue as to which of the two pictures the participant was required to attend to and which was the distracter. In Experiment 1, Spanish-dominant, Spanish-Catalan bilinguals in Catalonia and a control group of Spanish monolinguals in the Canary Islands named pictures in Spanish. Distracter images were either cognates between the two languages (e.g. taza/tassa, or cup in English), or unrelated words. The authors predicted longer reaction times in cognate distracter trials if cognate pictures activated the lexemes in both languages. This prediction was confirmed through a 34 millisecond interference effect. In Experiment 2 three changes were made to the paradigm: Catalan-dominant bilinguals replaced Spanish-dominant, pictures were named in Catalan and distracters were either phonologically related (but not cognates) or unrelated. As an example, one distracter picture included was squirrel (*ardilla* in Spanish) employed alongside the target picture vest. In Spanish, the distracter was phonologically related to *armilla*, the Catalan name for vest. A control group of English monolinguals was also tested in a separate experiment. The authors predicted faster bilingual reaction times for related pairs than for unrelated, because the target would receive activation from the phonologically related distracter words, a prediction which was confirmed. They suggested these findings presented evidence for dual phonological activation among the linguistic population tested, a result which was incompatible with theories postulating that activation does not proceed below the lemma level.

Colomé and Miozzo (2010:105) described their participants as 'very proficient bilinguals who regularly use both of their languages,' a population which thus 'probably provides the best possible

situation for observing L2 activation when L1 is being used.' They further comment that phonological co-activation in 'less proficient' bilinguals is a question still to be determined.

It may be questionable that the study's participants are the ideal group for testing whether L2 activation is observable during tasks in L1. First, it may be possible to contest that the speakers' language pairing is optimal. The author of the current study, along with other researchers (e.g. Wu & Thierry, 2010), would argue that observing co-activation in languages with relatively high levels of structural similarity may be less revealing than observing co-activation in languages with greater levels of structural distance. Wu and Thierry (2010) have suggested that large levels of overlap between two languages may mean that speakers do not function monolingually (i.e. that one language necessarily activates the other when the two are similar). As argued in Section 2.1 above, this study rejects the notion of the ideal bilingual speaker as one who is equally fluent in both languages, the two languages in perfect cognitive symmetry with no single language dominant; as Grosjean (2008) reminds us, the majority of the world's bilinguals present a far greater level of complexity in the relationship between their two languages. Furthermore, the activation of a weaker L2 during processing in a dominant L1 is reasoned here to be more revealing than co-activation of two similar languages in a region (Catalonia) where both are regularly used, or of a stronger language during processing in a weaker one. The difficulty of identifying suitable monolingual control groups for Catalan-Spanish bilinguals also undermines the notion of this population as ideally suited to research on dual activation - however, see Kaushanskaya and Prior (2015) for arguments against the need for control groups. In Experiment 1, the monolingual control are based in a region far removed from Catalonia, while in Experiment 2 the control group are not speakers of Catalan or Spanish.

These population comments aside, the picture-picture paradigm produced compelling evidence compatible with activation of non-target lexemes in near-balanced bilinguals, leaving the investigation of activation patterns in other dominance patterns as a matter for further investigation in future studies. It is also noted that the view that presenting single phonemes will activate all words containing that phoneme in the non-target language leads to a prediction for the findings of the current study. According to such a view, English-Punjabi participants in this study could be expected to activate picture names for non-target Punjabi during the task of monitoring English, because the distracter

phoneme itself would lead to the activation of Punjabi even in the absence of prior Punjabi activation. This prediction is returned to in the discussion of results in Section 5.1.

Wu and Thierry (2012) developed a novel activation paradigm which assessed the incidental translation of words. In their study, Chinese-English participants were tested in English and presented with on screen shapes which were either circles or squares. Participants responded through the keyboard to indicate whether the on screen shape was a circle or a square. In between the shapes English words were also presented, which the speakers were instructed to disregard (described as a go/no-go paradigm because some trials required a non-response). The distracter words were selected so that, if translated into Chinese, some of the words overlapped phonologically with the Chinese names for the shapes. For example, the English word 'reason' translates to *yin*, phonologically overlapping with Chinese word for circle, *yuán*. Distracter words in the control condition did not overlap phonologically with the Chinese shape names. The 45 participants were aged 18-26 and consisted of three equal groups: 15 were described as native English speakers (interpreted here to mean monolinguals); 15 were Chinese-English bilinguals; and 15 were described as native Chinese speakers tested in a separate version of the experiment using Chinese words (interpreted here to indicate Chinese monolinguals). The bilingual participants had commenced learning English at the age of 12 and had been based in the UK for a mean duration of 24.5 months where English was used in their everyday life.

Error data did not significantly differ between the English and the bilingual group, but did reveal a significant effect of the phonological overlap for Chinese control participants. ERP data revealed an N200 effect (associated with conflict monitoring and conflict control) for phonological overlaps for the bilingual participants, but not for English monolinguals. This effect was also observed in the Chinese control group. An effect present in the Chinese group but absent in the bilinguals was also evidence of motor preparation to speak.

The authors interpreted these findings to be consistent with a picture of processing in which:

a. the English distracter words presented automatically translated their Chinese equivalents for both the Chinese bilinguals and the Chinese control group, even though no form of linguistic attention to the words was required of participants;

b. Chinese participants performing tasks only in Chinese also suffered interference due to the within language phonological overlap;
c. the absence of preparation to speak in the bilinguals (but not the Chinese controls) may indicate that the Chinese activation occurring for bilingual speakers was inhibited before it could lead to a preparation to speak response, consistent with Green (1998).

The results thus indicated activation of a non-environmental, non-target language during a task which was predominantly non-linguistic, but which involved intermittent linguistic material from the environmental language. The study demonstrated parallel activation of both a bilingual's languages, activation extending to the lexeme level, evidence that bilinguals needed to manage consequent interference and some indication that dominant Chinese was subsequently inhibited by bilinguals. The result can be compared to Hermans' (2004) Competitor-Pho stimuli type, in which the distracter was phonologically related to a target word only in it its translated form.

In a subsequent study, Wu, Cristino, Leek and Thierry (2013) adapted this paradigm, suggesting that the 500ms duration and the fixation position of the distracter word above may have caused a deep level of lexical access. (The fixation location, at the centre of the screen, had been chosen to avoid methodological problems with ERP, in which eye movements can hinder accurate measurements of neural activity.) The new study utilised eye-tracking and a visual search paradigm. Stimuli were presented in an on screen grid format, one in each corner of a square grid with a fixation cross in the centre. Filler trials contained one shape and three English words, while test trials contained four English words, one of which was phonologically related to the Chinese shape name. Participants were given a choice of three key press options; two keys indicated each of the shapes, while a third key was pressed in trials which contained no shape. The authors anticipated that participants should look at the words only long enough to determine that they were not shapes, eradicating 'explicit linguistic processing' (2013:420). Bilingual participants were 20 L1 speakers of Chinese with L2 English, matched by a control group of 20 British monolinguals. Results showed that 'bilingual participants looked more frequently and longer at critical words as opposed to control ones' (Wu et al., 2013:423). The study therefore replicated the cross-language phonological effect achieved above in an experimental context which provided less opportunity to explicitly notice the distracter words.

Another study employing picture pairs as a means to avoid presenting linguistic stimuli was Wu and Thierry, 2011. Selected pictures in the study were presented with distracters which were semantically related, while other pictures were presented with distracters which rhymed with the target. Semantically related distracters were used as a measure of access to meaning, while rhyming distracters were a measure of cross-language phonological effects. Wu and Thierry chose to focus on processing in both languages during the same experiment, arguing that most studies in the literature assess whether processing in a weaker second language is impacted by a stronger first language not currently in use, leaving it unclear whether a weaker language not in use affects processing in a stronger language; this dual focus was permitted by an experimental paradigm which avoided explicit linguistic content.

Bilingual participants were 15 Chinese speakers aged 19-23 and resident in the UK for 18 months (so that, though Chinese was the stronger language it was not, at the current moment, the environmental language). Bilinguals had started learning English between the ages of 12 and 13 and thus were late bilinguals. The bilingual group was matched by an English monolingual control group. The experiments contained four conditions consisting of rhyming in English picture pairs, rhyming in Chinese picture pairs, semantically related pairs and unrelated pairs. In Experiment 1, participants were asked to indicate whether the distracter picture rhymed with the target picture, based only on English picture names. Experiment 2, undertaken by the bilingual group only, employed Chinese as the processing language. In this experiment, participants were asked to indicate whether the two picture names shared a character (both an orthographic and a phonological overlap). If performed together on the same day, the second experiment therefore presented a language switch for the bilingual participants, who went from making explicit judgements on English rhyme in Experiment 1, to making judgements on Chinese rhyme in Experiment 2.

In Experiment 1, English monolinguals showed faster reaction times for English rhyming pairs than all other conditions, with no effect for Chinese rhyming. For English-Chinese bilinguals, both Chinese and English rhyming pairs were associated with increased errors in comparison to semantically related and unrelated pictures, suggesting a cross-language effect from Chinese phonology even though participants were instructed to consider only rhymes in English. English rhyming pairs also showed a

reduced reaction time for bilingual participants. The results for Chinese rhyming (the non-target language) were mixed. While English (but not Chinese) rhyming pairs manifested faster reaction times than unrelated or semantically related trials, in a *post hoc* test the authors then tested for a significant difference between reaction times for Chinese rhyming pair trials and English rhyming trials and found no significant difference. This could suggest that both sets of rhyming pairs were facilitated by phonological similarity. ERP data showed reduced mean amplitude for the English rhyme condition compared to the unrelated condition, though this effect was smaller for Chinese-English bilinguals than for native English speakers. Rhyming in non-target Chinese was also associated with reduced mean amplitude for the bilinguals, but in a later time window (500-800ms) than the English target rhymes (250ms onwards).

In Experiment 2, completed only by bilingual participants, reaction times were faster for Chinese rhyming and semantically related pairs than for English rhyming and unrelated pairs. Error rates were also higher for Chinese rhyming and semantically related pairs. English rhyming pairs were not associated with either a faster reaction time or a higher rate of error than other stimuli types. ERP data also indicated a lack of effect by non-target English rhyming in this experiment.

The study was argued to be evidence that 'Speaking in the second language activates phonological representations in the first language, but not *vice versa*' (Wu and Thierry, 2011:6). In other words, though English had been the bilingual's environmental language for more than a year, a stronger and more dominant first language impacted upon processing in weaker, late acquired, second language, while the weaker second language did not impact upon the stronger first language. This possibility is consistent with the current thesis' suggestion that phonological activation in a less dominant language (as is English in Wu and Thierry's study) during processing in a weaker language would be more surprising than the reverse. However, the fact that English was the language of the participants' current environment (and presumably course of study) could have been expected to tip processing towards a greater influence for English, which does not seem to have been the case. Whether this processing pattern would apply to bilinguals in wider settings is less certain.

A second finding from the study was that ERP data showed activation in the two languages to be temporally distinct, such that when bilinguals responded to rhyme judgements in English, the

significant cross-language effect from Chinese activation occurred later than the within language effects from English. The authors interpreted this to indicate that retrieval in the intended language began first, followed by inhibition. This is more consistent with Green's (1998) proposal for early activation, than with Costa and colleagues' (1999) theory of language-specific selection. They argued this temporal picture to be consistent with bilingual co-activation, but suggested that the time course of co-activation and inhibition required further specification.

Third, some of the authors' comments on potential limitations are relevant to the current design. They conceded that an element of conscious monitoring within the design (which also exists during phoneme monitoring) may impact on response strategies. Specifically, the need to consciously analyse the picture name may cause bilinguals to internally name the words in both languages as part of their checking procedure. The authors suggested this might have occurred at a later point, once the participants were checking their responses. This interpretation will be discussed in Chapter 5, which will consider a complementary possibility that, in both the current research and also potentially Wu and Thierry's study, the non-target language could have needed to be checked and eradicated as a source of response error *because* it was active already.

A recent study by Spalek, Hoshino, Wu, Damian and Thierry (2014) adapted a paradigm developed for monolingual use by Damian and Dumay (2005, cited by Spalek et al. 2014; 1994) in which coloured line drawings were presented on screen and participants were required to produce a two word utterance indicating both the picture name and the colour. In the original study, participants named adjective-noun pairs containing a phonological overlap, such as 'blue bear,' faster than pairs containing no overlap, a facilitation effect deriving from phonemic repetition. In the bilingual adaptation of this task by Spalek and colleagues, speakers named adjective-noun pairs exclusively in their second language (English). Participants were a single group of 18 bilinguals (11 women) with L1 German and L2 English acquired between the ages of 8-19. The speakers were currently immersed in an English language environment for six months or more and the experiments were carried out in an English only context. The word pairs were split between those containing overt phonemic repetitions in English, those containing hidden cross-language repetitions and those containing no repetition in

either language. As an example of hidden cross-language repetition, the word pair red-skirt contained no phonemic repetition in English, but did in its German equivalent, *roter-Rock*.

The authors predicted that if lexeme level knowledge in the L1 was activated while undertaking the task in a non-dominant second language this should manifest in a priming effect arising from the covert cross-language repetition in German equivalents. As well as behavioural data, the study also used EEP and ERP measures and predicted that non-target lexeme access would be visible from 350ms. Behavioural data revealed no main effect for either language or phoneme repetition, but a significant interaction between the two. Pairwise t-tests showed reaction times to be faster when the English words contained a phoneme repetition and there was no significant speed difference in trials containing a hidden phoneme repetition in German. However, at 440-500ms from onset of the stimuli, ERP data showed a significant main effect of language. Further analysis of ERP amplitudes in different 50ms time windows revealed the effects of L1 German phoneme repetition to be significant at 300-350ms, while the effects of L2 English phoneme repetition was significant at 450-500ms. The findings demonstrated that L1 and L2 phonology are 'activated almost in parallel even though L1 phonology is not required at all' (Spalek et al., 2014:231). The authors suggested that non-target phonology was activated but subsequently inhibited prior to articulation. The authors further argued that the study was the first to show that non-target phonology is activated even in the absence of linguistic content from the non-target language, such as distracter words or cognates.

These findings are relevant to the current study in that they demonstrate a clear manifestation of non-target phonological activation during processing in a weaker L2 and map the relative time courses of phonological activation in both languages. The differences between linguistic populations in the current study and Spalek and colleagues' make this a useful point of comparison. Where the current thesis seeks evidence for phonological activation of a non-dominant language during processing in a dominant, environmental language, Spalek and colleagues have evidenced something approaching the reverse. Their study shows that a dominant language remains phonologically active during processing in a weaker second language while a weaker, non-dominant language is necessarily active because of the experimental demands.

Given the second research question of the current question, which asks whether phonological co-activation of the non-target language differs among bilinguals according to sociolinguistic speaker profile such as their usage patterns, the next section presents relevant sociolinguistic perspectives which will be applied to analysis.

## 2.5. Sociolinguistic Perspectives

This section now maps some of the key sociolinguistic perspectives applied to the current study. The application of these perspectives has been based on the hypothesised possibility for external, social contexts to impact upon activation states. It is widely believed that implicit linguistic processing does not operate in isolation from other areas of cognition but works co-operatively with other functions, such as the processing of pragmatic information. This applies both to views positing the existence of a specialised neurofunctional module for language (for an overview of the connectedness of the language system with other functions, see Paradis, 2004) and to views opposing modularity of mind (Barrett, 2006, provides a brief history of the intense debate about modularity of mind ). It should not, therefore, be controversial to posit that the socio-pragmatic landscape within which language is enacted may impact upon language processing itself, specifically upon whether, and how habitually, the language system activates each language. This notion is also implicit within Grosjean's (1998) theory of language mode (discussed below, in Section 2.5.1), which proposes that context triggers changes of activation state. Though served by two separate sub-disciplines, the social and cognitive aspects of language processing are therefore seen here to be intimately connected and exploiting relevant sociolinguistic perspectives to enhance the core investigation is seen to be appropriate and useful. (At risk of repetition, the distinction is emphatically made between *harnessing* sociolinguistic insights and *conducting* research according to sociolinguistic methods; this study is attempting to do the former and is does not in itself constitute a piece of sociolinguistic research.)

One key influence of sociolinguistics in this study relates to the assessment of speaker variation. Self-evidently, all bilinguals are not the same and bilingualism is not a static condition (Francois Grosjean, 1982). This non-exhaustive list of questions that might begin to build a profile of a bilingual person serves to illustrate just some of the multi-faceted complexity of bilingualism.

a. How long has each language been spoken? At what age did acquisition of each language begin? Was one language very well established before the other was introduced, or was acquisition simultaneous? Is the speaker a receptive bilingual, able to understood but not produce utterances in their second language?
b. Is a particular language only spoken and not read, or used only for reading religious text and never spoken?
c. If migration has resulted in a change of environmental language, how long has the speaker been immersed in the new environment?
d. What is the structural distance between the languages; are they very similar or grammatically and phonologically very different?
e. What usage patterns apply to a language? Is it for the home, only spoken respectfully to elderly grandparents and visiting relatives, or only used for work but never at home? Is usage confined to one particular domain, such as the law or liturgy?
f. What are the power relationships pertaining to each language? In a mixed language household, does English predominate amongst men and the young while another language predominates for women and the elderly? At a societal level, does one language attract prestige and the other derision or suspicion?

The first three aspects of a speaker profile are often reported in psycholinguistic literature, while there have been calls for greater account to be taken of the fourth (e.g. Wu and Thierry, 2010); however, (e) and (f) are examples of profile characteristics which rarely feature in activation or control studies. It is not possible to operationalise all potential variables in any single experimental study, nonetheless research investigating how the human mind manages two languages needs to be cognisant of underlying complexity in how individual speakers and linguistic populations differ. While mindful of the fact that the focus of psycholinguistics research in bilingualism is not on specific linguistic populations or individuals but on what bilingual processing reveals about wider human language system and cognition (Kroll et al., 2012), it is important to that purpose for speaker/population differences to be accounted for with care. One experimental design which offers a useful strategy for controlling speaker difference is the type of within-subject design utilised in studies such as Wu and Thierry (2013).

The study employed a single group of Welsh-English early bilinguals to test inhibitory control in two language contexts and was innovate in its use of a within-subject design to overcome issues in research on bilingual cognitive advantage, which typically compares bilinguals and monolinguals leading to many sources of potential confound. The study suggested that bilinguals display an increased ability to resolve interference in situations of mixed language use.

Another area of insight borrowed from sociolinguistics relates to issues of how usage of a speaker's languages may be delineated. The remainder of this sub-section now introduces a number of usage delineations and maps how they could theoretically impact upon activation states. These fields are exploratory and not exhaustive; as Fishman (1965:78-79) warns, no single study can approximate data collection and analysis 'in accord with all possible interactions between the many sources of variance and domains of language use' and should instead 'select only an appropriate sub-cluster of variables for simultaneous study.' The usage delineations mentioned below are not themselves the object of study, i.e. the current study is not focussed on finding out more about code-switching or topical regulation, etc. The purpose is rather an exploratory consideration of how a number of usage delineations might impact on processing.

First, the maintenance of bilingualism depends, at a basic level, on an individual choosing to speak each language. Though such as a statement appears simplistic, habitual language choice is described by Fishman (1965:1) as 'far from being a random matter of momentary inclination.' Moment by moment language choice takes into account many relevant factors, including the physical setting, social situation and the function of the interaction. Choice can be expected to interact closely with a speaker's language attitudes given that speakers frequently associate their languages with different attributes, seeing one as perhaps 'more dialectical, more regional, more sub-standard, more vernacular-like, more argot-like than the others,' and possibly also feeling one of their languages is best suited to 'informality, equality and solidarity than the other' (Fishman, 1965:70). Language attitudes may also affect the way individuals report proficiency. In their study of secondary school Spanish-English bilinguals in the US, Hakuta and Dandrea (1992), for example, found that self-reported proficiency differed considerably from actual proficiency, while variables based on attitudes to each of the speaker's languages held

predictive value for self-reported proficiency level; the authors went so far as to suggest that the self-report is 'as much a measure of language attitude as it is of proficiency' (1992:91).

Cumulatively, it could be anticipated that attitude and habitual language choice might affect the frequency with which each language is used, interacting with overall frequency effects. An overall frequency relationship of this kind would differ from word level frequency effects, which compare frequency levels within a specific language but not between two.

Another way in which language choice is regulated (Fishman, 1965, 1971) is according to the topic under discussion, known as topical regulation, with individuals who share languages preferring to switch into a particular language for discussion of certain topics. Topic as a regulator of language choice implies that particular topics are managed 'more appropriately in one language than another in multilingual contexts' (Fishman, 1972:439). Fishman describes topical regulation as driving language choices from a number of potential motivations, as listed below.

a. The topic may be associated with one language over another from nothing more than habit.
b. The topic may associate with one language over another because education or training on that topic was received through the medium of one of the languages.
c. The speaker or their interlocutor may lack the necessary specialist terminology associated with the topic in one language (i.e. the specialist terms exist in the language but are not known to the interlocutors).
d. The language itself may be lacking in the specialist terminology necessary for the topic.
e. Discussion of the topic in a particular language may be socio-culturally inappropriate ('considered strange') in the particular multilingual setting.

Fishman describes topic as a crucial consideration for understanding the variance that occurs within language choice. However, given the multiplicity of factors outlined above, language choice and topics are seen to have limitations in their capacity to predict language delineations at a wider level as they fail, by themselves, to account for the idea of language choice as 'related to widespread sociocultural norms and expectations' (Fishman, 1971: 441). These sociocultural norms and expectations are better served by Fishman's (1971:441) classical concept of the domain, a construct that 'summates the major clusters of interaction that occur in clusters of multilingual settings and

involve clusters of interlocutors.' Typical domain classifications may include family, school, church, government, etc. Fishman (1972) calls for careful use of this socio-cultural construct as domains and topic choices are likely to differ from setting to setting, possibly even between adults and children within the same linguistic population. He stresses the importance of the domain of the home, in which an individual's bilingualism often begins and as a domain into which bilingualism may retreat 'after it has been displaced from other domains in which it was previously encountered' (1972:443). Where language shift occurs, the degree of shift may differ among domains, though a stabilising of domain-specific use may occur. Designations of the domains operating within a linguistic population are considered to be naïve where they are derived from data of macro-level analysis of a whole society, rather than through analysis of micro-level (individual) face-to-face interactions (Fishman, 1972).

One hypothesised processing relevance for topic and/or domain is the possibility that words in the non-target language may have differing activation thresholds dependant on how frequently topical regulation or domain cause them to be used. As stated in Section 2.3, Activation Threshold Hypothesis suggests that, with each instance of activation, a word's threshold is lowered and fewer impulses are required for reactivation, while lack of use sees the threshold gradually rise. It is possible to speculate that the relationship of topic with processing could also extend beyond simple frequency of use and relate to the organisation of activation. This hypothesis is consistent with the theory of language mode (see Section 2.5.1) which allows for the possibility that if a particular topic is far more strongly associated with one of the speaker's languages, a shift into that topic might be sufficient to cause the language system to prepare for a language switch. Such a possibility differs from effects of cumulative usage levels and hints at the possibility that preparation for future use could be more strategic than simply dictated by top-level quantity of use.

Code-switching, in contrast to topical regulation and domain, may be considered a mechanism of connecting rather than of separating languages[6] (cf. comments in Section 2.7.4 on the possibility that switching patterns in British Punjabi use may point to the development of Punjabi as a mixed code). Nonetheless, as codes-switching is not a random muddling of two codes, it involves micro-level delineations of when and how each language will be employed, entailing an exquisite level of control.

[6] Li Wei, personal communication, 7 October 2013.

A hypothetical potential relevance of code-switching to processing patterns is that it can be expected to involve maintaining high levels activation of each language, while managing interference and switching costs occurring multiple times within a sentence. The impact of such a sophisticated form of language control on processing could manifest as lower activation thresholds in each language and/or enhanced capacity for control. While code-switching does not occur in all speech communities (Heller, 1988), Romaine (1989) suggests that code-switching is prevalent and frequent among British Asian bilinguals, the population studied in this research, though Chana and Romaine (1984, cited by Dewaele and Wei, 2014) also report the existence of some negative attitudes towards code-switching among Punjabi speakers. Pert and Letts (2006) found code-switching employing Mirpuri as the frame language to be common among Pakistani heritage children with L1 Mirpuri Punjabi and L2 English living in Rochdale. Code-switching prevalence among English-Punjabi bilinguals may impact upon the periods for which Punjabi is ever out of use.

Definitions of code-switching include the juxtaposition of passages of speech from different grammatical systems/sub-systems within the same utterance (Gumperz, 1982), the ability of bilinguals to alternate between their codes during the same conversation (Myers-Scotton, 1998) and 'the use of more than one language in the course of a single communicative episode' (Heller, 1988:1). Gardner-Chloros (1991:46) finds code-switching to be 'an inherently ambiguous term' investigated in non-overlapping manners by sociolinguists and psycholinguists, two traditions, she feels, which regrettably 'largely ignore one another'; the former field is concerned with the results of switching and with theories of suitable transition points for code-switching, while the latter is more concerned with the act of switching itself and with the mental process implied in actioning a switch. It is important to differentiate between intra-sentential code-switching (within a sentence or clause), insertional code-switching (borrowing) and tag-switching (Toribio, 2001) such as can be found in the utterance 'Beautiful, *henna*?' ('Beautiful, no?'). Muysken (2000:1) is careful to apply the blanket term code-mixing to switching where aspects of two languages are shared within a single sentence, reserving code-switching to only those cases where there is a 'rapid succession of several languages within a single speech event'. Grosjean (2008) differentiates between a 'full' code-switch, which may necessitate a complete (if brief) shift to another language, and borrowing, which involves only taking a morpheme

or word and adapting it morpho-syntactically and/or phonologically to the more active language. Myers-Scotton (2000) differentiates between marked and unmarked language choices about which language to use and whether (or how) to switch; an unmarked choice is linguistically expected for the situation and interlocutors, while a marked choice of language breaks convention and may constitute an attempt to negotiate a new norm. Within this context, code-switching is an intentional social message based on a calculation that initiating a switch yields advantages over and above continuing in monolingual discourse (Myers-Scotton, 2000). In Myers-Scotton's (1993) Matrix Language Frame model, one language dominates, supplying morpho-syntactic structure to the clause into which the less-dominant language is embedded. Alternatively, Muysken (2000) postulates three key patterns of switching: the insertion of items from on language to another, alternation between structures and congruent lexicalisation (situations where lexical items can fill the grammatical structure of either language equally well).

Heller (1988) rejects the idea that code-switching can be distinguished from borrowing or other contact phenomena on purely formal grounds, foregrounding instead the role of code-switching in negotiating social identity, enacting social action and constructing social reality. Heller (1988:11) stresses that code-switching must been seen in its ecological setting in which each speaker has differential levels of access to multiple roles and may be 'more or less able to use certain resources to social, discourse or referential effect.' She argues that code-switching is significantly tied to separation by language domain with an important role in levelling social boundaries, possibly facilitating brokering between language domains.

It can be expected that highly switched languages are less likely to remain out of use for long blocks of time, which may impact upon activation thresholds. For instance, the processing system of a speaker who knows that language B will only be used in finite blocks may be less likely to prepare for use of that language once conversing in language A. Thus, it could be argued that frequent code switching could maintain the readiness-to-use of each language, manifested in lower activation thresholds. This point, like topic/domain, relates more to the processing system's structured expectations for likely imminent use than to matters of frequency or overall quantity of usage. In this

regard, it bears a similarity to language mode which concerns itself with triggers instigating preparation for likely imminent use.

An important methodological point relating to code-switching is that speakers may be unable to consciously report on code-switching behaviour with any accuracy. Even though code-switching may be a norm within a particular speech community, speakers who are asked for information on their own code-switching and presented with examples of different types of switch may not recognise them as part of their own repertoire of behaviour or be able to identify the kind of switching used (Heller, 1988). As the current study does not include a component of naturalistic language observation, what can be gleaned about code-switching from conscious reporting (such as used in this study's survey of language use, reported in Section 3.4) is limited.

At the outset of the study the relevance of the theoretical areas outlined (language choice, topical regulation, domain and code-switching) in this sub-section were speculative and tentative. Their potential impact on processing has informed the design of the study, most particularly in the focus given to usage in survey design (see Section 3.4), in the use of post-experiment interviews (reported in Section 4.1) and in approaches to statistical analysis (see Section 4.2).

### 2.5.1. **Language Mode**

Of crucial interest to any attempt to measure activation states is the language mode in which the bilingual currently operates. Grosjean (1998:136) proposes a mode to be a 'state of activation of the bilingual's languages and language processing mechanisms.' In this view, the mode of a speaker is seen to be affected by *external* factors and a non-exhaustive list of potential factors is given by Grosjean which includes: interlocutors and hearers; proficiency, mixing habits, attitudes, interaction patterns, kinship relation, and socio-economic status of those hearers and interlocutors; the situation, including physical location and whether there are monolinguals nearby; how formal the interaction is and how intimate the speakers are; the nature of the content (form, topic, lexis required, mixing); and the function of the interaction. In an experimental setting, these factors may include what the participant knows about the aims of the research, the task/task demands and the stimuli. This focus on external factors can be contrasted to Paradis' (2004:191) comment that 'the greater availability' of an item may condition

speaker choice, suggesting that internal processing constraints could drive external language behaviour as much as external factors determining internal activation states.

The language mode theory conceptualises language mode as a continuum of many possible activation states. At one extreme of the continuum, the activation state is in monolingual mode in which only one language is activated. Grosjean describes the monolingual mode as arising when a speaker is interacting solely with monolinguals and the 'topic, situation or purpose of the interaction' dictates sole use of the monolingual interlocutor's language (1998: 136). At the opposite extreme, an activation state that is fully in bilingual mode has both languages activated. A mid-point on the continuum also exists in which one language is more activated, but the other is partially activated (such as might be the case during conversation with a bilingual who shares both languages but is using only one). As well as the degree of activation of each language, the theory also concerns the choice of 'base language' in which the speaker is primarily operating. Grosjean stresses fluidity in the operation of mode; due to the range and complexity of the factors involved, he posits individual variance in speakers' patterns of language mode, that shifts can occur at any time and that they are unconscious (2008:45). Language mode is rooted within the theoretical idea of activation, but more oriented towards explaining how external factors, such as interlocutor, impact upon activation levels and each language's preparedness for use.

Grosjean considers at length the impact of language mode on experimental psycholinguistic studies of bilingualism (considered again in Section 2.5.1). Those that include words from both languages, Grosjean argues, make it difficult to determine whether the results are produced because participants are in bilingual mode as a result of the stimuli. Studies that seek to assess non-selective processing should be clear whether the results are due to the participant having been in bilingual mode during the experiment, or whether they were obtained in monolingual mode and cannot, Grosjean argues, be adequately explored in bilingual mode. As well as ensuring that task demands do not themselves induce bilingual mode, Grosjean suggests recruiting both monolinguals and bilinguals and masking the purpose of the experiment until later (also discussed in Section 2.5.1).

One of the most pressing issues for studies of processing arising from Grosjean's theory is the question of determining (never mind controlling) monolingual mode. Grosjean cites a number of studies (e.g. Treffers-Daller, 1997) that move forward evidence for language mode. However, they

provide information specifically on whether a direct manipulation of mode alters naturalistic language production and switching behaviour. In this regard, they arguably impact more on a researchers' capacity to verify that a switch in bilingual mode has occurred, more than on their capacity to verify that a speaker is in monolingual mode. A bilingual speaker performing an experimental task that does not involve producing speech is extremely difficult to assess. Beyond the overall cautions above, the author is not aware of a method for verifying with validity that a speaker is in monolingual mode.

As a final comment on mode before it is returned to later in the study, it is not clear whether all speakers will respond to experimental manipulations of mode in the same way. Given the fluidity and individual variance in speakers' patterns of language mode suggested by Grosjean (2008), a researcher cannot, it is suggested here, control for seemingly small or insignificant catalysts (e.g. receipt of a text message from a particular interlocutor moments before the experiment, the triggering by one picture of a particular memory associated more with one language than another, etc.) inducing a movement along the continuum in the direction of bilingual mode.

### 2.5.2. **Methodological Implications**

In 1998 Grosjean suggested that the literature on bilingualism contained conflicting results which might have been reduced with greater attention to certain methodological and conceptual issues. Though some time has passed since these evaluative remarks were made, they remain a useful benchmarking point for consideration. Four key areas touched on by Grosjean (1998) are pertinent to a number of the studies discussed in Section 2.5.1 as well as to the methodology of the current study, detailed below and in Chapter 3.

Grosjean's first point was that that many studies fail to recount the full complexity and variability of their bilingual participants. (Some indication of the wide-ranging aspects of bilingual profiles which might be relevant to activation patterns is also given above, in Section 2.5.) Grosjean suggested these factors should include language history, the functions for which each language are used, proficiency across different modalities, how much time the bilingual spends using each language and biographical data including gender, socio-economic status and levels of education. Grosjean maintained that insufficient information about participants makes it difficult to compare results across studies and he proposed two possible remedies, the first of including bilingual assessment measures as covariate

variables during analysis and the second of adding appendices containing some of these biographical details (Francois Grosjean, 1998). This approach may not be entirely unproblematic however; in a discussion of bilingualism and executive function, Kaushanskaya and Prior (2015) suggest that co-variates on language skills can strongly associate with a variable like executive function, challenging the assumptions of ANCOVAs. Though executive function is not explicitly under study in all research on bilingualism, this criticism underlines the difficulty of definitively isolating variables within bilingualism from all other factors.

Secondly, as also discussed in Section 2.5.1., Grosjean's theory of language mode presents a complex challenge for the field and it is not clear whether full control of this variable is within reach. Masked recruiting would certainly appear to be difficult to achieve in conjunction with the previous point on participant complexity, as such complexity entails a need to control as closely as possible for bilingual variability and this involves asking detailed questions of the participants about their language histories at the outset. In this regard, it is argued here that Grosjean's advice pulls in opposite directions, proposing both lengthier and more in-depth exploration of bilingual profiles and also initial deception about the bilingual nature of the study, rendering controlled sampling difficult. Masked recruitment might also be problematic to reconcile with ethical requirements that participants give informed consent based on an understanding of the research in which they are participating. The extent of ethical problems is admittedly limited to a violation of informed consent; psycholinguistic experiments do not harm participants and the true nature of the study can be revealed at the end of the process at which point a participant might be given the option to refuse permission for the data to be used.

Setting aside valid ethical concerns, however, the practical difficulties of such a recruiting approach may be difficult to surmount, particularly where the population is under-researched, difficult to recruit and must be carefully specified (such participants by their nature are less likely to be easily reached en masse). A researcher is essentially faced with the choice of an open call for participants in the hope that some of the preferred participants serendipitously volunteer, or a specified call for participants, which propositions the importance of their languages by profiling them and, as Grosjean cautions, inducing bilingual mode. The option of open call recruitment could conceivably work somewhat better in situations of high speaker density, such as recruiting speakers at a community event

organised for a festivity in the Chinese calendar without revealing that the research is specifically interested in Mandarin speakers. Where research funding is short and participants are reimbursed for their time or travel, however, open call recruitment may be seen as unnecessarily costly.

Where masked recruitment has succeeded in securing participation from the desired speakers, further care is required. Grosjean (1998) cautions against showing any interest in the prospective participant's bilingualism, testing them in a laboratory that is known to focus on bilingualism, or conducting testing with a bilingual tester. He puts forward the suggestion of making participation compulsory as part of a course and testing all students in order to gain access to bilingual students. Again setting ethics (and the interests of the extraneous monolingual participants) aside, clues to the overall purpose of the study may remain if the principal researcher's name is in any way connected with the process, as the research interests of named individuals are easily retrievable within minutes by those participants sufficiently curious to enter the name into an online search. Overall, masked recruitment presents significant practical challenges and is particularly difficult to achieve in combination with careful control and description of bilingual participants. For these reasons, the current study has not employed masked recruitment, as further discussed in Section 3.2.

Grosjean's (1998) third point relates to task confounds and stimuli. He suggests that words can differ in multiple ways including: graphic forms, including their frequency and the frequency and density of neighbouring forms; phonetic forms, including their frequency and the frequency of phonetic neighbours; syntactic categories; concreteness-abstractness; and animacy. These differences are, he suggests, very differently defined across the literature. He argues that as many of these differences should be controlled for as possible. Furthermore tasks may involve either automatic processing or strategic processing and the task itself may activate both languages (e.g. a mixed naming task in which a symbol or background colour cues the participant to name an item in a certain language, with trials switching between the languages). Grosjean proposes that tasks should be monolingual in nature and not involve use of both languages or cross-priming.

The breadth and scope of Grosjean's evaluations and cautions are broad and no claim is made here that all are met in the current thesis. Masked recruitment, for instance, and profiles of socio-economic status have not been included (detailed in Sections 3.2 and 3.1 respectively). It should also be pointed

out that psycholinguistic results which appear to conflict may also be usefully unveiling finer-grained processing differences in linguistic populations. Nonetheless, these cautions remain important and are referenced in the methodological outlines in Chapter 3.

Finally, beyond the cautions of Grosjean, a considerable limitation of psycholinguistic approaches acknowledged here is their reliance on the experimental context and artificial language settings, as opposed to natural speech. Use is made of de-contextualised single word paradigms or carefully controlled whole sentences. This limitation means that careful interpretation of psycholinguistic results is required, though not necessarily always in the direction of limiting the implications - an effect such as co-activation observed experimentally at the level of the single word can be expected to occur at a potentially *larger* scale in the context of non-experimental speech (even if followed by the kinds of disambiguation hypothesised in Section 2.2).

It is possible, however, to find challenged to the starkness of this view from perspectives within sociolinguistics. Wolfson's (1976:202) examination of the problem of natural speech in linguistic research argued that qualitative methods too could be seen to fall short of capturing natural speech, suggesting instead that the concept of natural speech itself is misinterpreted:

> 'The important point to be made here is that there is no single, absolute entity answering to the notion of natural/casual speech. If speech is felt to be appropriate to a situation and the goal, then it is natural in that context.'

On this basis, interview talk, while natural within the context of a research interview, is not natural in other settings and cannot be presented as context-free. The interviewee does not, for example, feel the right to introduce new topics and narratives that do occur in an interview setting have different characteristics to those which occur outside elsewhere because 'speech does not exist independently of the situation in which it occurs' (Wolfson, 1976:208).'

It may be possible to venture on this basis that, while experimental linguistic processing is specific to the context and interacts with task demands, nonetheless *all* processing may be said to be responding to contextual factors of some kind. Context may influence, for example, what processing attends to (e.g. discourse level intonation may signal that important information is about to be delivered), is limited by (e.g. lexical selection may be complicated or delayed by the need to select only words from an appropriate register due to the interlocutor or hearers) and what processing will do next (e.g. an

appraisal of the interlocutor may establish the likelihood of an imminent switch into a different language, with consequences for the activation of that language).

### 2.6. Summary of Relevant Studies

This section now provides a summary of relevant findings relating the core review question of whether activation in the non-target language proceeds to the level of the lexeme, after which the aims of the current study will be presented in details.

Hermans et al. (1998) contended that activation proceeded only as far as the non-target language lemma level, based on the failure of a through-translation, auditory distracter word to produce effects at +150ms. The specific distracter types, such as 'berm' in relation to target word MOUNTAIN, were not phonologically related to the target word in their presented form, but if automatically mentally translated by the participant they became phonologically related to a cross-language competitor word ('berg'). However, it is possible that the processing route of the through-translation distracter used by Hermans et al. (1998) could have involved a longer time-course than distracters in paradigms such as phoneme monitoring (Colomé, 2001). It might be speculated that production is well advanced before a through-translation distracter can produce effects observable in behavioural data. Interestingly, Wu and Thierry (2012) did find an effect through translation, but this effect was not observable in behavioural data. Their study required participants to indicate whether on-screen shapes were a circle or a square; intermittent written distracter words were presented which, if translated into non-target Chinese, overlapped phonologically with the Chinese shape name. ERP data was consistent with inhibition in trials involving through-translation phonological overlap and the authors concluded that the English distracter words were automatically translated to Chinese but that translation words were then rapidly inhibited. In both Hermans et al. (1998) and Wu and Thierry (2012), the non-target language was a dominant L1 which might be speculated to require greater inhibition than a weaker language.

Spalek et al. (2014) also provided evidence for the activation of non-target phonology in a dominant L1 followed by inhibition, giving a clear manifestation of non-target phonological activation during processing in a weaker L2 and map the relative time courses of phonological activation in both

languages. As commented in Section 2.4, the differences between linguistic populations in the current study and Spalek and colleagues' make this a useful point of comparison.

Evidence for non-target lexeme activation has been produced by cognate picture naming such as Costa, Caramazza and Sebastián-Gallés (2000) but this is treated cautiously here due the possibility (as argued, for instance, by Wu and Thierry, 2011) that cognates artefactually activate items in both languages. This study involved the presented of whole words in written form which were cognate across both languages, making it very difficult to determine whether the task is the cause of the co-activation.

Colomé's (2001) study is viewed here as strong evidence for phonological co-activation in a population in which both languages are spoken regularly and to a high degree of formal proficiency. Though linguistic information is presented during the experiments, it does not take the form of whole words. The proposal of Costa, La Heij and Navarette (2006) that the presentation of a single phoneme could artefactually lead to the activation of the non-target language has been discussed. This view is considered problematic because it presupposes the capacity for all words in both languages with a particular phonemic onset to receive activation because of the presentation of that phoneme. The author of the current study is not aware of evidence to support the idea that this would be the consequence of presenting a single phoneme. An alternative, weaker possibility is that existing activation of the non-target lexeme could be increased by the phoneme presentation. Despite their theory, Costa, La Heij and Navarette (2006) acknowledged that Colomé's study provided compelling evidence for non-target activation.

The potential issue raised by Costa, La Heij and Navarette (2006), which is not supported here, was circumnavigated by Colomé and Miozzo's (2010) study, which avoided linguistic distracters of any kind and investigated phonological co-activation through the presentation of picture pairs instead. This study also provided compelling evidence for co-activation to the level of the non-target lexeme.

The studied reviewed provide clear evidence for the activation of non-target phonology in near-balanced bilingual speakers, while the activation (followed by inhibition) of a securely dominant non-target language has been demonstrated. What is missing from this picture is a picture of whether a far less dominant language is activated to a deep level during processing in a securely dominant and

environmental language. The population choice of the current study has been strategically selected to address this gap.

The current study assesses evidence for phonological activation of a far less dominant, weaker language (here Punjabi) during processing in a securely dominant environment language (English). Habitual, deep-level co-activation of the weaker language is certainly not intuitive in this scenario, unless taken as evidence that both languages are perpetually active regardless of relative dominance and usage patterns. Given the role of English in this language pairing as the dominant, environmental and target language, Punjabi activation is markedly less expected. Findings such as those by Wu and Thierry (2012) indicate a securely dominant language will be swiftly inhibited; a far lower degree of inhibition (if any) is anticipated for the non-target language profile in this study. The research here presented avoids distracters reliant on a through-translation effect. It is not anticipated that an absence of interference from Punjabi would be caused by forceful inhibition of Punjabi given its non-dominance. Neither is it anticipated that an absence of interference from Punjabi would be caused by the time-course needed for through-translation effects to be manifested in behavioural data, as through-translation stimuli have been avoided.

An additional absence in the studies reviewed is an examination of bilingual variance based on fine-grained sociolinguistic differences between speakers in the same population. Though there have been new calls for increased specificity in the profiling of bilingualism (see, for instance, Kaushanskaya and Prior, 2015) and claims that monolingualism and bilingualism may even represent different ends of a single, multidimensional spectrum (Luk, 2015), most studies attend less to issues of processing adaptation. The only study mentioned in the thesis to argue a role for recent processing context is Wu and Thierry (2013), which suggests that immediate linguistic context may have an online interaction with cognitive function. It is acknowledged that this is an argument for effects of processing on control, and of immediate linguistic context rather sociolinguistic profile. Nonetheless, this perspective is of interest in that it differs to processing arising from long-term bilingualism (e.g. age of acquisition) or to static representation (such as, arguably, proficiency). The viewpoint rather suggests that dynamic and changing recent language usage/exposure could affect not only linguistic processing, but also domain general non-linguistic cognitive function.

The study does not attempt to evidence issues such as whether selection is language-specific.

Having summarised the key findings of the review and how this study is positioned in relation to relevant research, the remainder of this chapter now presents the aims of the current study in more detail.

## 2.7. Aims of the Current Study

The final section of this chapter now specifies the aims of the current study.

### 2.7.1. Research Questions

The current study seeks to extend evidence of whether activation of the non-target language extends beyond semantic representations to the lexeme during bilingual speech production. In assessing indicators of lexeme-level activation, the study also explores interactions between non-target language activation and variegated sociolinguistic profiles, considering whether variance in bilingual processing can be accounted for (even partially) by fine-grained language usage patterns.

The precise research questions of this study are as follows.

1 During language processing in a dominant language, is a less-dominant, non-target language also active at the lexeme level?

2 Does lexeme level activation in the non-target language differ among bilinguals according to sociolinguistic speaker profile (such as their usage patterns) and what are some of the relevant factors influencing processing?

The phoneme monitoring method was selected as the basis of the current study. While some researchers have claimed that a single phoneme may create activation, the processing of such an effect has not been specified in any detail. (Other studies of bilingual processing reviewed above have since employed other suitable methods of testing non-target lexeme activation, such as paradigms involving picture-picture pairs or visual search, however these were published after the current study was underway). Phoneme monitoring continues to offer advantages over methodologies introducing activation artefactually in the form of whole words, introduced as written or aurally presented distracters, or of cognates which are presented as whole words and are likely to have closely related representations across the two languages.

Phoneme monitoring has been adapted here and applied to British Asian speakers of English and Punjabi. Given that Punjabi is far less dominant than English in the study's participants, attracts low prestige among speakers (Rahman, 1996) and, it would be argued here, sits in a national context attaching low value to bilingualism, any evidence for non-target Punjabi activation is of considerable interest, suggesting that even very securely dominant languages are vulnerable to interference from second language processing.

### 2.7.2. Role of Dominance, Proficiency and Usage

Previous studies have varied in the dominance patterns of the linguistic population studied. The current study opts to focus on whether dominant language processing is impacted by a weaker language, as evidence that a non-dominant and lower proficiency language will interfere with a securely dominant environmental language is arguably less expected.

The dominance patterns explored in the current study differ markedly from the linguistic community featuring in Colomé's study, which were Catalan-Spanish bilinguals in Catalonia. Speakers in Catalonia receive formal education in and through both languages with a requirement that a certain level of proficiency is reached in both, therefore speakers' dominance/proficiency balances can be speculated to be relatively close. Both languages also feature, to different extents, in everyday public life in Catalonia (though one language may feature more in certain domains). In sum, proficiency and education is high in both languages, the structural distance between the languages is not great and both languages are a feature of the everyday environment to some degree. As explored in Section 2.1, bilingual speaker profiles are often a good deal more complicated than the Catalan-Spanish context and the phenomenon of dual activation requires examination through a range of speaker profiles if it is to be fully understood.

The current study investigates the activation patterns of speakers whose languages are far from balanced and whose languages exhibit greater structural distance than do Spanish and Catalan; the English-Punjabi speakers in the current study were dominant in the environmental language, while education and literacy developed solely within English. This population is well suited to exploration of whether a less dominant, naturally-acquired community language is phonologically active while performing tasks in a more dominant environmental language. Within the population, certain factors

have been controlled for as far as possible to a level which is comparable to the linguistic controls of the studies presented above (matches in many areas exceed other studies, though the age range of the current study has been wider). However some degree of variance in the patterns of usage is considered inevitable and examination of this variance is a key component of the study.

While mindful of the importance of proficiency to understanding bilingual language processing, this study accords far greater methodological priority to examining the role of patterns of language usage, for several reasons. First, a meaningful measure of proficiency, while important in general terms, presents some prohibitive limitations with regards to the specific linguistic population in question. The British speakers of English and Punjabi featured in this study have, on the whole, no formal education in Punjabi and no literacy with which to access more complex language or widen their spheres of vocabulary. Their use of Punjabi is thus limited in *breadth* to a domestic, familial sphere. Measures of components of proficiency such as, for instance, breadth of vocabulary or the range of syntactic structures mastered, may contribute little to the profile of the speakers (both are anticipated to be limited). Treffers-Daller (2015) also points out that complications in that other facets of bilingual competence, such as their sociolinguistic knowledge, are under-investigated. Such considerations are highly relevant to speakers in the current study. Self-ratings are likewise likely to provide an impoverished measure where participants are conscious of a lack of formal education in the language. The focus of this study is in no way related to or subject to establishing formal proficiency, but concerned rather with measuring whether participants' Punjabi knowledge – whatever view may be taken of their proficiency level – is activated to the lexeme level. In other words, the study asks not how much Punjabi a speaker knows, but whether the Punjabi they *do* know is active.

Researchers of 'heritage speakers' (bilinguals who naturalistically acquire a home language as well as an environmental language) caution as to the applicability of comparing proficiency between certain bilingual populations and monolingual proficiency norms; Rothman and Treffers-Daller (2014:95) argue that heritage speakers are indisputably native speakers of both the environmental language and the home language if both languages were 'acquired from naturalistic exposure in early childhood and in an authentic social context/speech community.' The native speaker competence of heritage speakers may, argue Rothman and Treffers-Daller, result in grammars that vary from monolingual native

speakers. Adult heritage speakers may also suffer from attrition of different competence outcomes to native speakers of the home language. Nonetheless, such speakers cannot be regarded as other than native speakers of the language in question. Comparisons between the proficiency of a heritage speaker's home language and monolingual norms in that language are also argued to be problematic in this literature. Cabo and Rothman (2012) point out that notions of heritage speakers as having incompletely acquired the heritage language ignore input differences; heritage language input has been affected by language contact scenarios and qualitatively differs to that received in monolingual contexts. Thus what appears to be non-target grammar may in fact be fully convergent with the input received (complete acquisition of a different style of the same language, which can be contrasted with arrested development and with attrition). Comparative proficiency differences between heritage speakers and monolinguals in the heritage language are therefore highly problematic.

Cabo and Rothman suggest a more appropriate comparison group would be first generation migrants of the same linguistic population. In certain types of study, such a comparison would offer the advantage of comparing subjects with the speakers who produced the input on which heritage speakers' language is modelled. The comparison would not, however, fit with the current study design as first generation Punjabi speakers are also bilingual and would simply represent a second bilingual group, nor could they serve as a control group in any way given different residency patterns and other mismatches. Bespoke design of detailed test materials was considered to be beyond the resources available to the current study; development of a meaningful test would require in-depth study of the first generation speakers within participants' households.

While traditional measures of proficiency are argued to be less suited to the linguistic population of heritage speakers under study, the role of fine-grained usage is speculated to have an important and under-examined role in adaptive language processing. A useful analogy to the tension between language proficiency and usage is offered by Thomas Bak[7], who, in relation to cognitive advantage, makes a comparison with the protection from cardiovascular disease offered by swimming. In his analogy, becoming a proficient swimmer at an early age and subsequently ceasing to swim offers no protection from cardiovascular disease, while learning much later and swimming poorly but regularly offers

[7] Personal communication, 6 May 2015.

considerable advantage – in such a scenario, use bears more importance than simple proficiency. Similarly, the view taken in this study, is that the dynamic and shifting demands of a speaker's ongoing usage patterns are likely to play a role in the language system's patterns of activation. This view is consistent with definitions of bilingualism which might be seen to foreground usage over proficiency (e.g. Grosjean 1998, Mackey, 1962, Weinreich, 1953, reported on page 9); such views stress that a speaker becomes bilingual by virtue of regular *use* of the languages in question, rather than through absolute proficiency measures such as monolingual-like breadth of vocabulary, or mastery of a specified range of grammatical structures. It also echoes more recent comments in the literature on the importance of processing context and bilingual variation (Kaushanskaya & Prior, 2015; Luk, 2015; Wu & Thierry, 2013).

### 2.7.3. **Monoliteracy**

As argued in Section 2.2, it is not a given that research approaching bilingualism through the lens of bi-literacy will produce results which are applicable to all bilinguals. While official estimates are difficult to locate, the high probability of monoliteracy being widespread among the world's bilinguals can be accepted with relatively little contention, which entails expanding the field's focus to encompass monoliterate as well as bi-literate bilinguals. Participation in the current study was limited to lifelong English-Punjabi bilinguals with negligible or no exposure to Punjabi literacy. No specific hypothesis is forwarded here about how Punjabi literacy would impact activation patterns beyond the possibility of access to Punjabi literacy potentially leading to shifts in frequency of use (with other concomitant impacts on language representation), neither is impact ruled out.

To mirror the study's methodological limitation to monoliterate bilinguals, orthographic stimuli were carefully avoided. Rather than employing orthography to index phonology, the current study used auditory presentation of phonemes in the phoneme monitoring experiment. As well as being necessitated by the monoliterate participant base, this approach is argued to have advantages over orthography. First, the varying orthographic depth (Katz & Frost, 1992) of different languages and conventions of connected speech mean it is not always possible to map a language's phonemic repertoire onto letters in a one to one relationship. Certain letter presentations may be ambiguous as to the phoneme presented. Secondly, phonemes may appear in some words without being represented

orthographically (e.g. /z/ in dogs). Thirdly, the auditory presentation of phonemes approaches nearer to conditions in conversation, in which the speaker produces speech in the context of oral/aural interaction.

### 2.7.4. Linguistic Population

The current study is based on a linguistic population of British Asian adults with lifelong usage of English and Punjabi. Punjabi is an Indo-Aryan language with subject-object-verb word order. According to Bhatia's (1993) descriptive grammar, Punjabi nouns inflect for number (single/plural), gender (masculine/feminine) and case (simple/oblique/vocative) and it is the 'only Indo-Aryan language to have developed tonal contrasts' (Bhatia, 1993:343). Bhatia suggests Punjabi has been in use as a literary language since eleventh century and is subject to complex variation.

British Asians make up approximately 4% of the UK population and are highly likely to be bilingual, but are under-studied in psycholinguistic explorations of bilingual processing. Data based on child speakers in the UK suggest that Punjabi speakers are one of the larger linguistic communities among British Asians; national school census data reveal that, of 815,450 bilingual children of compulsory school age in January 2008, 102,570 reported being Punjabi speakers (CILT, 2011). Speakers in the UK have family origins in India, Pakistan or other Indian-diaspora countries such as Kenya. Census data on ethnicity (Office for National Statistics, 2005) reveal a population of 1,053,411 (1.8%) Britons of Indian origin and 747,285 (1.3%) Britons of Pakistani origin. The same source outlines a number of cultural similarities between Indians and Pakistanis (such as a tendency for larger households, low rates of inter-ethnic marriage) but also key socio-economic differences: unemployment rates for Indian men are similar to white British men while rates for Pakistani men are roughly twice those of white British men; Indians are more likely than white British people to have a degree, while Pakistanis are less likely (40% of Pakistani women and 28% of Pakistani men have no qualifications); GCSE performance for Indian pupils is higher than white British performance, while for Pakistani pupils it is lower than white British performance. These data suggest that, while there are linguistic and cultural overlaps between families with India and Pakistan as a country of origin, there are also socio-economic dissimilarities.

The addition of two new questions relating to language to the UK population census in 2011 revealed Punjabi to be the main language for 273,231 speakers (aged 3 plus) in the UK, however this figure does not cover participants in the current study for whom English is the main language and does not therefore give an accurate picture of the total number of British speakers[8].

One potential methodological challenge arising from the choice of population group is that Punjabi's history leads to a possible divergence, linguistically and socially, amongst speakers. At the time of Partition the designation of the new international border between West Pakistan and India divided the Punjab region in two. As a result, the language is now autochthonous in two different states. Post-Partition, Punjabi is spoken by over 60 million people (48% of the population and the largest single language) people in Pakistan (Rahman, 1996) and over 27 million people in India Ethnologue, n.d.).While Punjabi is usually spoken of as a single language, its use in two states holds open the possibility of divergence. According to Shackle's (1993) review of Modern Standard Punjabi, the language as used in India has been subject to some degree of standardisation and Sanskritisation, while in the less altered Punjabi of Pakistan there remains a strong element of Perso-Urdu vocabulary. For contemporary British speakers of Punjabi there is also divergence at a more local level. Based on linguistic populations in different regions of the UK (Oxford and Birmingham), Stuart-Smith and Martin (Stuart-Smith, 1997, Stuart-Smith and Martin, 1999) have described the emergence of a distinctly British 'community Punjabi' which differs to standard Punjabi and which has incorporated widespread English lexis. Stuart-Smith and Martin (1999) specifically describe a researcher's difficulty in being understood by children when the researcher used a formal, unmixed Punjabi with Birmingham school children in a study of phonological awareness; the children were better able to understand once the researcher switched to community Punjabi, which was described as a low status variety of Punjabi unsuitable for use in written form. This variation has methodological implications, entailing a need to include a check that all participants use the same glosses for Punjabi lexical items in the experiment. The flexibility of the paradigm to tolerate some level of phonetic variation is discussed in Section 3.5.3.

Hawkins (2003) argues that, as well as linguistic information such as segmental (allophonic) and prosodic information, the speech signal contains information about a speaker's identity, state of mind

[8] More broadly, the 2011 census data is also not able to reveal the full number of bilinguals in the UK, only those bilinguals for whom English is not the main language.

and attitudes. Hawkins speculates that mental representations of words may be formed from exemplar memories, complete with fine phonetic detail, and emphasises the vital role for fine phonetic detail in communicative function. Where Hawkins stresses that listeners aim to arrive at meaning rather than to uncover linguistic units, in the current study no whole words are presented and the auditory stimuli are decontextualized segments based on abstract linguistic units (phonemes) with no communicative function in their own right. Nonetheless, the author of the current thesis acknowledges the firm potential for fine phonetic detail in these stimuli to have contained clues to speaker identity.

Sharma (2011a) assessed retention of Punjabi accent features, specifically t-retroflection /ʈ /, by speakers in the London borough of Southall. Retroflex /ʈ / was selected on the basis of being exogamous to British English, while also a marker of British Asian speech. Her study explored whether features of the speech of participants' parents which were not native to the local variety of English would be filtered out or retained. Migrants born in India but living in Southall were compared with British-born second generation members of the Indian diaspora, now resident in Southall. The second generation speakers were divided into two age groups, those born 1960-1970 and those born 1970-1995.

Sharma comments on the theory (Labov, 1972) that an individual's speech is more influenced by peers than by parents and highlights that the distance between parents' speech and their children's is markedly greater in situations of migration. The study contrasts a strong, cognitive version of peer orientation, in which accent features from parents are lost, with a weaker version which permits for the possibility of some continuing elements of parental speech. Both postulations, in Sharma's view, locate the point of transition at a boundary between native use of British English (as occurs in the second generation) and non-native use (i.e. by migrants themselves). A third possibility presented by Sharma allows for the possibility of social factors playing a role. Two sociolinguistic/biographical interviews were conducted with 74 participants (42 of which feed directly into the study), while a smaller subset made self-recordings in a range of speech settings.

Different patterns emerged for older and young second generation speakers. Younger second generation speakers used retroflexion less frequently than older second generation, but placed retroflexes they did use in word-initial positions (considered by Sharma to a highly salient positioning)

while glottal stops were used in medial and final positions. Older second generation speakers operated a dual competence, changing neither system significantly and appearing to be a more complex transitional group. Sharma concluded that nativeness did not constitute a simple boundary point at which Punjabi accent features would be cognitively re-allocated to local accent features, as it was only in the younger end of the second generation that reallocation from retroflexion to glottal stops appeared to be becoming embedded.

Interestingly. Sharma found that 'those who speak more Punjabi are not necessarily the ones who have more /ʈ/ in their English' (2011a:418) and that network ties were a strong factor. There was also a gender aspect in that younger second generation females compartmentalised their registers more strictly than male, using a high degree of Punjabi features in the home and fewer outside the home. Sharma argued that contextual social changes (specifically improvements in race relations and cohesion in Southall) had contributed to sociophonetic change, in that they reduced the need to sound purely British in an atmosphere of threat. Rather than passing as purely British, younger second generation forms of speech contained 'emblematic markers of Punjabiness' (2011a:423) while remaining clearly distinct from the accent of recently arrived migrants.

Evidence of the retention of Punjabi/Urdu features in British Asian speech has been found in other studies. Kirkham (2011:1105) identified a number of markers of British Asian articulation of /t/ and /d/, including 'a shorter and louder burst with a more retracted place of articulation.' Research by Lambert, Alam and Stuart-Smith (2007) confirmed the perceptual reality of a local Glasgow Asian accent containing phonetic features not found in non-Asian monolingual Glaswegians and which had their origin in Punjabi/Urdu features such as retroflexion. Lambert et al. (2007:1511) also hypothesised the possibility of a relationship between 'specific social practices and topics of conversation and the use of more or less retracted variants.'

The age of speaker who produced the oral stimuli for the current study (stimuli are described in Section 3.5.3) aligns with Sharma's category of younger second generation speakers. While the speaker was not a resident of Southall, Sharma's study might suggest that the stimuli used could likewise have carried markers of British Asian speech which would be recognisable to participants in the current study. Sharma's suggestion that proficiency may not have a simple mapping onto the retention of accent

features and that the wider picture of contextual social usage is salient is also of interest to the current study. Speakers were excluded from the current study if their Urdu proficiency was considerable, so while the British Pakistani participants can be expected to have some receptive exposure to Urdu, it was not habitually used by them for family or social communication.

Another, social issue of divergence is the sociolinguistic attitude to Punjabi among speakers. In the countries of origin, Punjabi inhabits different political and sociolinguistic contexts. While in India, Punjabi is a respected vehicle of religious expression and achieved official status as the state language of a Sikh-dominated Punjab in 1966, the sociolinguistic context of Punjabi is considerably different. According to Rahman (1996) the Punjab province is the country's most prosperous region and Punjabis as a distinct group in a multi-ethnic state dominate in national government, administration and the army. However the over-representation in government and relative power of Punjabi-speaking Pakistanis is not reflected in language usage. English remains the language of the administration, the judiciary, the military, of education and of commerce, while Urdu is the medium of education in most state schools, in the lower levels of administration and in major cities (Rahman, 1996). The Punjabi language in Pakistan therefore lacks widespread use for education, local government or written media and, though powerful as a social group, its speakers tend to access their power through the medium of Urdu or English.

Commenting on the social attitudes to the language, Rahman presents two facets which may be relevant to the study here presented. First, the Punjabi *language* (but not its speakers as a social group) appears to be accorded low prestige in its Pakistani context. As reported by Rahman (1996:199-209), activists for greater use of Punjabi maintain that there is a cultural shame attached to its use and hold it in affectionate contempt, while educated Punjabis teach Urdu and English to their children.

Secondly, Rahman suggests that Punjabi is a marker of intimacy and informality, much used for humour. Rahman's point leads to another facet of Punjabi's position in Pakistan which may prove relevant to the current study: speakers rarely access literacy through the medium of Punjabi as evidenced by its absence from education and media (Rahman, 1996). This low role for literacy in Punjabi usage has also been witnessed in studies of Pakistani Punjabi speakers resident in the UK. In an interview-based study of pre-school literacy in British Pakistani families, one mother outlined the

relative roles of English, Urdu, Punjabi and Arabic as follows: 'All are important, English for here, Urdu for letters to Pakistan, Punjabi for the family to speak altogether and Arabic for the Qu'ran,' (Hirst, 1998:419). These remarks indicate a delineation in which Punjabi is the main language for plenary family conversations.

Based on these descriptions, British Punjabi speakers can be expected to be frequently monoliterate with no formal instruction in or through Punjabi and may, furthermore, often attach low prestige to the language. While the purpose of the current study as a psycholinguistic investigation is to learn about the architecture of the language system rather than about a specific linguistic population (Kroll et al., 2012), the intention of this study was also to perform the psycholinguistic investigation through an authentic linguistic community of UK bilinguals. On this basis, a participant pool restricted to biliterate Punjabi speakers (or entirely restricted to university undergraduates) might have been unduly skewed. No claim is made that the study sample is representative of British Punjabi speakers, but sampling has also not sought a restrictive participant profile in order to more closely resemble the 'ideal' bilingual.

The linguistic and sociolinguistic nature of the population chosen also imposed several constraints on the word list of the experiment (detailed in Section 3.5.1). Constraints arising from the sociolinguistic nature of the population were a product of the patterns of language acquisition and use in the speech community. First, due to its absence from the British educational system,[9] use of Punjabi is likely to have been limited to the home and familial environments and possibly religious settings. Even within this home environment, it is also possible that some discourse areas may be covered predominately in English. This specificity of domain and register imposed a heavy constraint on the range of Punjabi vocabulary which could be assumed. As a consequence, certain words were excluded in favour of those judged more likely to be a common feature of everyday domestic life.

Another severe restriction requiring careful design was the possibility that dominance switches might have occurred among participants at a relatively early age due to the shift from home to school language environments. Assuming that dominance switches to English between the ages of five and eight, few assumptions could be made about the extent of Punjabi lexical acquisition beyond this age.

[9] Martin and Stuart-Smith (1998) comment on the challenge this presents for school children from linguistic minorities.

It was also speculated that several of the normal means of vocabulary acquisition open to a child - such as literacy, media content, conversation with teachers, peers, older siblings - may possibly have been accessible to participants only through English. In such a scenario, Punjabi may still have continued to develop after the age at which dominance shifted to English, however it was important for the design of the study to anticipate the possibility of Punjabi vocabulary acquisition having progressed at a much slower pace than for English. As a consequence, the population choice dictated that lexical items included in the experiment should be deliberately skewed towards an early typical age of acquisition.

Some linguists studying Punjabi use in the UK have questioned whether English elements have been embedded into Punjabi to such a degree that Punjabi has become a mixed code. Romaine (1995) describes the development of a mixed code as long-term intensive contact between languages resulting in the development of a mixed language, possibly with lexical affiliation to one language and the structure of a second. Romaine (1995:325) challenges a perceived reluctance for researchers to move away from a view of a single language as 'a structured self-contained whole, an autonomous entity, which is consistent with itself.' Other researchers, such as Reynolds (2002), have also reached the same conclusion about Punjabi as a mixed code in UK use. In a study of Punjabi, English and Urdu use among speakers in Sheffield, Reynolds (2002) observed the development of a mixed code among the ten families studied, specifically through the addition of English to the variety of Punjabi used. He reported English having been 'embedded into Punjabi and Urdu speech in a regular and predictable manner' (2002:155).

The plausibility of Punjabi use in British speakers having incorporated sufficient features of English as to be developing into a mixed code is acknowledged here[10]. Two observations are offered on this possibility. The first is that, while studies such as Reynolds (2002) characterise British Punjabi as irreversibly penetrated by English elements, the study does not claim that English-Punjabi speakers' use of English with *non*-Punjabi speakers likewise contains embedded elements of Punjabi which can only be removed with difficulty or which cannot be removed at all. The current study therefore draws a distinction between (a) monolingual speakers of a single Punjabi-English mixed code, on the one

[10] The current study did not attempt to verify whether the Punjabi variety in use by participants was a mixed code; only lexical items from Punjabi featured in the experiment in reported in this thesis and only those participant responses in which participants knew the Punjabi word were included in analysis. No shared lexical items such as 'shop' or 'tomato' featured in the experiment.

hand, and (b) bilinguals who speak Standard English *in addition to* a variety of Punjabi which has been heavily penetrated by English elements. Speakers in the current study make daily use of English with non-Punjabi speakers in a range of settings including education, work and social networks, and are able to exclude Punjabi lexis without difficulty as appropriate. It is argued here that they are thus best categorised as bilinguals of Standard English plus a second code. (For brevity and ease of reference, the thesis refers to the Punjabi spoken by participants as a 'language.')

Notwithstanding the view taken here that the English-Punjabi speakers in the current study are certainly bilinguals rather than monolinguals, it is appropriate to consider them as different to those bilingual populations in studies by Colomé (e.g. Colomé, 2001, Miozzo and Colomé, 2010). The processing consequences of a mixed code can only be guessed at here, but some possible processing outcomes are suggested. If the mixed code is considerably influenced by the speaker's other language, the structural distance between the two speaker's languages must be considered to be considerably reduced. Reduced structural distance might, hypothetically, influence the degree of co-activation compared to language pairs containing much greater structural distance. During use of a Punjabi variety which has been heavily influenced by English lexis, it could be anticipated that lexical representations which serve both English and Punjabi would be accessed. However, the phonetic features in articulation of shared words such as 'shop' or 'tomato' would vary considerably between Standard English and Punjabi. Thus, even in monolingual use of Punjabi with other Punjabi speakers, the likelihood for frequent accessing of lexical representations shared with English seems high. Overall, speakers in the current study present an interesting potential case for future efforts to operationalise bilingual usage as a continuum rather a discrete category and more research on the activation implications of mixed code use is needed.

### 2.7.5. **Hypothesis and Design**

Research question 1 was addressed experimentally. The phoneme monitoring paradigm was used to assess whether, during speech tasks which explicitly involve only one language, there is evidence that the non-target language is also receiving activation at the lexeme level. The experiment specifically sought evidence for whether the presentation of a picture would lead to activation of not only the target language, but also the corresponding lexemic representation in the non-target language.

Two activation scenarios are contrasted in Figures 2 and 3 below. In both scenarios, the presentation of a picture sends activation to a corresponding concept. Activation flows from this conceptual representation to a corresponding lemma in the target language ('apple' in the examples given). Once activated, the target lemma, apple, in turn activates its corresponding lexeme in the target language.

**Figure 2 Scenario A: Phonological Activation in One Language Only**

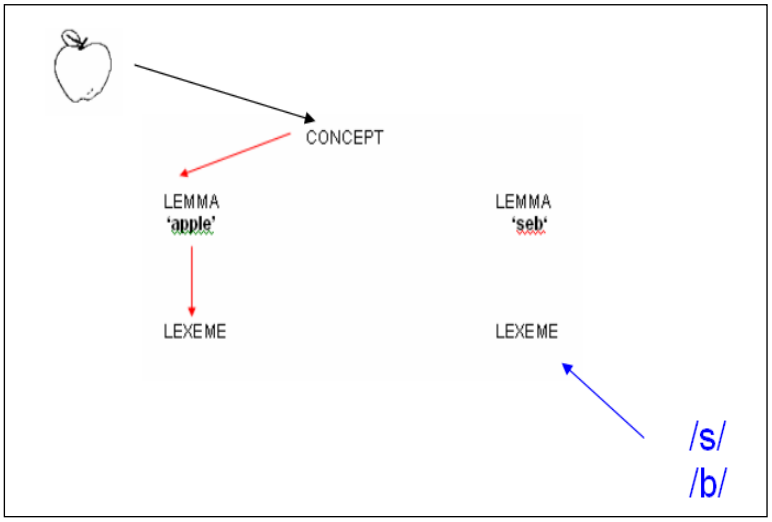
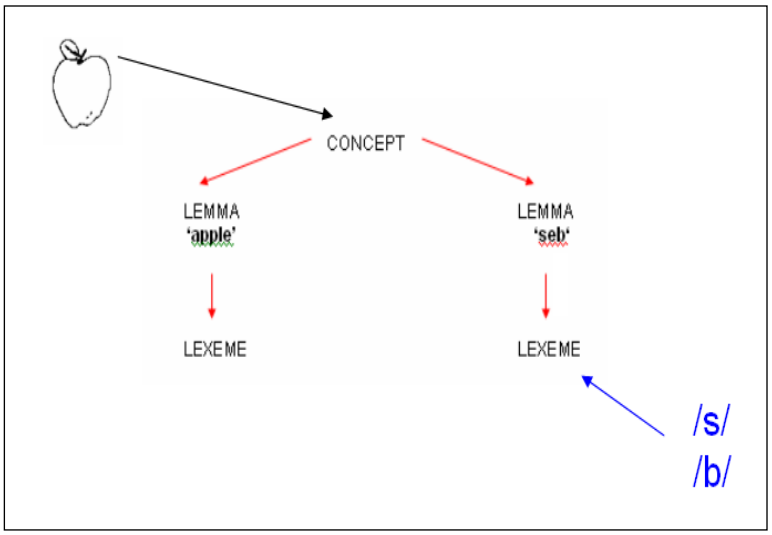



**Figure 3 Scenario B: Phonological Activation of Both Languages**




In Scenario A (Figure 2), activation flows either through layers of representation in the response language only, or reaches lemmas in both languages, but does not progress to the level of the non-response language lexeme. In such a scenario, a distracter phoneme from Punjabi should not cause interference in comparison to a distracter phoneme which occurs in neither language and reaction times for Punjabi phonemes should not significantly differ from those for unrelated phonemes.

In Scenario B (Figure 3) the presentation of a picture activates the corresponding concept which in turn sends activation to the corresponding lemma in the target language, (English 'apple'), to the corresponding lemma in the non-response language (Punjabi, *seb*) and from there to the non-target language lexeme. Where both language lexemes are activated, it is expected that a distracter phoneme from Punjabi would cause interference resulting in a longer reaction time for the rejection of /s/. As has already been stated, any evidence for Punjabi activation would suggest that even securely dominant language may still be affected by processing of the non-target language. Within-group variation (i.e. differing bilingual responses) was also anticipated as a possibility on the basis that individual speakers' language systems adapt to linguistic contexts, which may change on an ongoing basis.

Research question 2 was addressed by using language usage patterns gleaned from a survey of language usage (described in Section 3.4). Further in-depth interviews with selected bilinguals also explored patterns of language choice and informed analytical approaches, in particular a focus on interlocutors. Potential predictive variables were generated from survey data, with a focus on interlocutor data as highlighted in interviews; these usage variables were then tested for their ability to account for bilingual variance. Chapter 3 now presents these methods in more detail.

# Chapter 3. Methods

This chapter sets out the implementation of the study. Participants are first described (Section 3.1), including recruitment methods (Section 3.2) and ethical considerations (Section 3.3). This is followed by a description of the survey (Section 3.4) and the phoneme monitoring experiment (Section 3.5, including stimuli, construction, software, piloting and procedure). Research was undertaken in the following order: survey/experimental data were completed first with bilingual participants; interviews with a subset of bilinguals were next undertaken, overlapping with some monolingual experimental data collection. Analysis of interview data preceded quantitative analysis. Interviews are described more fully in Section 4.1 and quantitative analysis is described in Section 4.2.

## 3.1. Participants

In total 128 participants completed the study (excluding piloting and stimuli testing), split evenly between a group of 64 bilinguals and 64 monolinguals. At the design stage, power analysis was used to determine minimum sample size (47), which was exceeded. All participants, monolingual and bilingual, completed the phoneme monitoring experiment. All 64 bilingual participants also completed the language use survey, while ten bilingual participants took part in interviews.

### 3.1.1. Bilingual Group

Bilingual participants were 64 normal, right-handed adults with corrected-to-normal vision, balanced for gender (32 male and 32 female). Demographic data reported in this section were taken from the survey of language use (presented in Section 3.4). Ages ranged from 18 to 44 with a mean age of 31. Participants were all from families with two South Asian parents, were all British born, British raised and educated and were British citizens. No participants had lived outside the UK for more than a year. These eligibility criteria were applied to limit the variance in language experience among participants. This approach avoided conflating, for instance, speakers with experience of living in highly multilingual South Asian environments and those who had lived exclusively in English-dominant UK

environments. In the majority of participants' families (87.5%, n=56), neither parent had been born in the UK. In a minority of families, either one (6.3%, n=4) or both (6.3%, n=4) parents were UK born. No information was collected on sibling order. The family country of origin for participants was split between India (50%, n=32), Pakistan (45%, n=29) and Kenya (5%, n=3). Reported faith membership is provided in Table 1 and educational levels in Table 2.

**Table 1 Reported Faith Membership of Bilingual Participants**[11]

| Faith | n | % |
|---|---|---|
| Sikhism | 30 | 46.9% |
| Islam | 28 | 43.8% |
| Hinduism | 3 | 4.7% |
| Buddhism | 1 | 1.6% |
| Atheism | 2 | 3.1% |
| **Total** | **64** | **100%** |

**Table 2 Reported Educational Level of Bilingual Participants**

| Qualification Level | n | % |
|---|---|---|
| School-leaving | 3 | 4.7% |
| A Level or equivalent | 18 | 28.1% |
| Undergraduate degree | 26 | 40.6% |
| Postgraduate degree | 17 | 26.6% |
| **Total** | **64** | **100%** |

All bilingual participants were exposed to both Punjabi and English on a daily basis throughout childhood, hence were native speakers of both languages and early bilinguals. All were educated in the British education system through the medium of English. All but two participants had acquired English prior to starting school at age 5; hence between birth and five years, both languages were being acquired for most participants, while for two participants, English acquisition started only upon starting school. Participants were asked if they could recall the order of acquisition in the 0-5 age period, though the recollections were treated cautiously. Recollections were split, with just over half reporting that both languages had been acquired simultaneously (54.7%, n=35) and just under half reporting that Punjabi had been acquired slightly earlier than English (42.2%, n=27). Participants were asked to recall their stronger language on arrival at school: 45% (n=29) reported that English was already stronger, 33%

[11]Based on calculations from 2011 census data, 10.6% of British South Asians are Sikh, 54.5% are Muslim, 21.1% are Hindu, 0.2% are Buddhist and 2.1% are atheist, thus the faith membership of participants was not perfectly aligned with the broader population. These calculations were made by the author based on residents of England and Wales, and included the ethnicity categories Indian, Pakistani and Bangladeshi, but not 'Asian-Other'.

(n=21) that Punjabi was stronger and 22% (n=14) perceived their languages to have been roughly equal at the start of school.

Childhood dominance self-reports are generally difficult to validate (cf. the views of Hakuta and Dandrea (1992), reported in Section 2.5, that proficiency self-ratings may be no more than a measure of language attitude). However, given that all participants were English dominant by adulthood, it is possible that a proportion of the participants (specifically among the third of participants who believe they entered school with stronger Punjabi than English) may have moved away from Punjabi dominance and increasingly towards English dominance during the course of their childhood. Other participants were already English dominant on entry to the school system.

Dominance in English was both anticipated and an eligibility criteria, in part because Punjabi dominance or near-balance was considered unlikely in this population profile (due to English language schooling, absence of formal Punjabi education or literacy, etc.). More importantly, an English dominance criterion was necessitated by Research Question 1 (During language processing in a dominant language, is a less-dominant, non-target language also active at the lexeme level?). Adult dominance was established as English on the basis of usage and environment using data from the survey of language use (approaches to defining dominance are discussed in Section 2.1). Across the bilingual group the realms of work, social life and education were dominated by English for all participants (see Section 4.3.1); English also played a significant role in home environments (Section 4.3.1), occupied the role of environmental language and was the only language through which literacy was accessed. The participants sampled were overwhelmingly monoliterate, having either no knowledge at all of Punjabi literacy through Gurmukhi[12] (65.6%, n=42), or having received very little beginner-level instruction without regular use (31.3%, n=20). Only two participants self-reported sufficient literacy in Punjabi to be able to read a Gurmukhi-script newspaper, but this was not a skill they habitually used. The sample thus had a high degree of participant homogeneity in most key areas as monoliterate, second generation, British Asian, English-Punjabi speaking, early bilinguals. There was some controlled variance in age and education (which the recruitment of monolingual participants attempted to match, see Section 3.2 for recruitment methods), with a split between those who acquired English a year or

[12] An orthographic script associated with Punjabi use in India.

two later than Punjabi and those who reported that both languages were present from birth. No information was collected on socio-economic status as this is not commonly measured in psycholinguistic studies of bilingual processing[13].

### 3.1.2. **Monolingual Group**

English-speaking monolingual participants were 64 normal adults with corrected to normal vision, balanced for gender. No survey accompanied the control group experiment but screening checks were made to ensure each participant had no knowledge of any other language beyond GCSE level, were right-handed and did not have visual/hearing impairments or learning disabilities. Education levels of the monolingual group are reported in Table 3. The mean age of the monolingual group was 29.18 years (range 18-44) as compared to 30.78 (range 18-44) for the bilingual group; matching the age ranges of both groups was an attempt to mitigate against the possibility of an age effect in the data due to the wider than average age range of participants. An independent samples t-test confirmed that the bilingual and monolingual groups did not significantly differ in age, $t(119)= 1.16$, $p=.257$, and a Mann-Whitney test indicated no significant difference between education levels of the two groups ($U=1940$, $p=.950$).

**Table 3 Reported Educational Level of Monolingual Participants**

| Qualification Level | n | % |
|---|---|---|
| School-leaving | 1 | 2% |
| A Level or equivalent | 20 | 31% |
| Undergraduate degree | 25 | 39% |
| Postgraduate degree | 18 | 28% |

### 3.1.3. **Interview Sub-Sample (Bilingual)**

Ten bilingual participants, described in Table 4, attended a research interview further exploring their usage of and attitudes to their languages. These interviews were conducted after the experiment, but prior to experimental analysis. The purpose of the interviews was to explore language usage and use this information to inform the analysis of within-group variance (as reported in Sections 4.2 and

[13] For a review of the effect of socio-economic status on language ability such as vocabulary acquisition and its interaction with bilingualism, see Calvo and Bialystok (2014). Though socio-economic status has been linked with the range of language children are exposed to and themselves produce, the author is not aware of studies suggesting that lexical access is altered in terms of manner or speed by socio-economic status. While socio-economic information on the linguistic population studied is given in Section 3.6.4, the particular aspect of linguistic processing under examination in this thesis was not felt to warrant the collection of socio-economic profiles for participants.

4.3.3, interview data informed how survey variables were prioritised and aggregated, including a focus on interlocutors which arose from interview data). The methods and outcomes of the interviews are reported in Section 4.1.

Invitations were sent by email to 25 of the 64 bilingual participants, representing a split of genders and a mix of faith and regional origin of the Punjabi (the selection of 25 was pragmatically based on regional proximity to the author). The purpose of the interview was explained in emails as the wish to explore participants' language usage in greater detail in order to illuminate and inform experimental analysis. The ten participants who agreed to be interviewed were predominantly female (seven females, three males) and were all Muslim with a family origin in Pakistan, meaning that the sub-sample was not fully representative of the 64 bilinguals in terms of faith membership, gender, or family country of origin. Informants' households varied between those in which participants lived in their parental home and those in which the participant had moved away from the parental home and lived with a partner and their own children.

**Table 4 Interview Informants**[14]

| Informant | Gender | Age Group | Faith | Household | Education |
|---|---|---|---|---|---|
| 1 | M | 20-29 | Muslim | With parents | Current undergraduate |
| 2 | F | 20-29 | Muslim | With spouse & child | Current undergraduate |
| 3 | M | 30-39 | Muslim | With parents & grandparents | Bachelor's degree |
| 4 | F | 30-39 | Muslim | With spouse & child | School-leaving |
| 5 | F | 18-19 | Muslim | With parents | Current undergraduate |
| 6 | M | 30-39 | Muslim | With parents & grandparents | Bachelor's degree |
| 7 | F | 30-39 | Muslim | With spouse & child | Bachelor's degree |
| 8 | F | 18-19 | Muslim | With parents & grandparents | Current undergraduate |
| 9 | F | 20-29 | Muslim | With parents | Current undergraduate |
| 10 | F | 30-39 | Muslim | With spouse & child | School-leaving |

### 3.1.4. **Test Participants / Volunteers**

A number of additional individuals took no part in the survey, experiment, or interviews, but assisted with pre-testing and preparation of the experiment and its constituent stimuli.

[14] Existing participant numbers are not given, as individuals' interview responses were not analysed in direct relationship with their experimental data.

a. A single individual, aged 35, from a British-Pakistani background consulted and translated an initial list of Punjabi words as a check against the possibility that the list was skewed towards Indian varieties (this check is described in Section 3.5.1).
b. Twenty-five English-Punjabi bilinguals responded to an online survey eliciting Punjabi translations for a list of English names provided, as a check on initial word pairings (described in Section 3.5.1).
c. Twenty-five English-speaking volunteers assisted with testing by naming each picture (described in 3.5.2).
d. Fifteen English-speaking volunteers listened to individual sound files, collated into a single MP3 file, to test for intelligibility (described in 3.5.3).
e. Ten individuals, of whom five were English-speaking monolinguals and five were English-Punjabi bilinguals, completed a pilot experiment (described in 3.5.4).

## 3.2. **Recruitment**

Efforts to channel bilingual recruitment through niche organisations such as faith groups (temples, mosques, religious societies, etc.) or through ethnicity-based community organisations proved extremely problematic; most attempts of this variety resulted in the discovery that the organisations in question poorly represented British-born Asians in the target age range. A more successful subsequent strategy involved persuading large, neutral, non-faith, non-ethnicity-based mediators such as employers or universities to pass on information about the study. Efforts were made to avoid recruiting all participants from university student populations so that the study was somewhat more representative of a wider population,[15] however one pragmatic consequence of this choice was the need for a wider than average age range of participants; given the degree of difficulty in recruiting participants, it was not possible to adhere to a very narrow age range. Previous studies, such Balota and Duchek's (1988) study of lexical access in adults aged 63-79 and 18-36, have suggested that, though the rate at which activation spreads may not be affected by age, the speed at which words are recognised and responded to slows with age.

[15] Over-reliance on undergraduate samples within psychology has been criticised, e.g. by Hartley, J. (2013), Experimental social psychology relies too heavily on sample findings from undergraduate students. *LSE Impact Blogs*. http://blogs.lse.ac.uk/impactofsocialsciences/2013/07/09/experimental-social-psychology-of-undergraduates

Recruitment was mainly clustered in five key locations within the UK: London, Birmingham, Reading, Slough and Leicester. PDF flyers were emailed to employers, educational institutions, student groups, faith groups and academic departments. Information was also posted onto social networking websites, deposited in taxi offices, gyms, job centres, community buildings, libraries, job centres and posted direct to households in some areas of high density British Asian population. Notwithstanding these efforts, recruitment was protracted and extended beyond 18 months.

In recruitment materials the project was described as a study of 'how the mind manages two languages.' Materials specified some of the eligibility criteria for participation, including use of Punjabi since infancy, thus it was apparent to volunteers that Punjabi was an integral component of the study. The possibility that participants consequently attended the research session in bilingual mode, with Punjabi somewhat prepared for use (Grosjean, 2008), is acknowledged. As discussed in the section on methodological implications (Section 2.5.2), Grosjean's recommendation of masked recruitment might have avoided this potential pitfall, however, masked recruitment was considered too problematic to employ on many levels. First, a generic call for participants, regardless of whether they spoke Punjabi, could not properly be targeted; establishing proper controls for the Punjabi sample could only be conducted after they had completed the experiment, potentially consuming a great deal of time in testing inappropriate participants. Secondly, deception presented an ethical problem in that it would have prevented participants from giving prior informed consent. In partial mitigation of this possibility of bilingual mode, other cautions from Grosjean were met by the current study: the experimental sessions were conducted by the author, who was known to participants to be a non-speaker of Punjabi; instructions specified that the experiment should be undertaken only in reference to English, thus indicating that English was the only language they should be preparing to use; and the experimental stimuli contained no explicitly-Punjabi content.

Potential participants responded to recruitment notices by sending emails of enquiry. Prospective participants were provided with a participant information sheet and consent forms (see Appendix 1). Preliminary eligibility checks (e.g. establishing that broad language history was aligned to the study) were conducted by phone or email. Based on these checks, suitable participants were invited to a testing

session and at the session itself further eligibility checks (more detailed language histories) were achieved through completion of the survey (described in Section 3.4).

Recruitment of monolingual participants proceeded within the same geographical localities as for the Punjabi group. Participants in both groups were paid £10 for their participation. (Volunteers assisting with testing mentioned in 3.1.4 were either recruited online or through the author's professional networks and no remuneration was offered.)

## 3.3. Ethical Considerations

Ethical approval was obtained from King's College London prior to the start of data collection (Education and Management Research Ethics Panel, reference REP(EM)/08/09-22). Each participant's right to withdraw was stressed repeatedly on at least three occasions: during the first email contact; verbally at the test session; and in writing at the test session (via instructions and the consent form). Participants were offered the opportunity to withdraw up to one month after the test session and have their data destroyed.

As mentioned above, masked recruitment to the study was rejected on the basis that it would hinder participants' capacity to give informed consent in advance of taking part. While the purpose of the overall study was in no way masked, the exact mechanics of the experiment (specifically the two experimental conditions) were not explained prior to testing, neither were participants forewarned that they would be asked to produce Punjabi names for each of the 20 experimental pictures at the end of the experiment; doing so would have led them to prepare for imminent use of Punjabi and so activate the language.

In the interests of sharing the knowledge generated by the research, individual participants were offered the opportunity to learn their personal experimental results, specifically whether a slowing trend was observed in the trials involving a distracter phoneme. In order to share results with participants, some of the experimental design was explained at the end of the session when this knowledge could no longer impact on experimental performance. The potential interpretation of results was carefully phrased to avoid suggesting that a result in either direction was optimal, or that results in any way indicated a 'weakness' of Punjabi; participants were instead informed that the result could indicate whether their Punjabi was active/inactive during the task.

After entry of survey and experimental data and transcription of interview recordings, data was anonymised.

### 3.4. **Survey of Language Use**

A language survey was designed[16] (see Appendix 2) for English-Punjabi bilinguals with several functions. First, the survey established the basis for inclusion/exclusion in the study. Questions established that participants were early bilinguals with acquisition of both languages occurring in infancy through familial use rather than formal instruction; had used both languages daily throughout their childhood; were British born and educated (levels reported in Table 2); right-handed, with corrected-to-normal vision, of normal hearing with no reported learning disability; and were aged 18-44 (the reasons for a larger than average range in participant age are discussed in the Section 3.2 above). Participants were excluded from the main study in the following cases.

- They had not spent their childhood and all of their education in the UK.
- They were fully bi-literate, possessing good literacy in Punjabi through the Gurmukhi script and making use of the skill on a regular basis. A small degree of exposure to beginners' tuition in Gurmukhi was tolerated.
- They spoke Punjabi and English but reported also knowing Urdu and used Urdu more than Punjabi, or knew any other third language beyond basic beginner level[17].
- They were left-handed or reported a hearing defect or learning disability.

Secondly, the survey recorded areas of remaining variation amongst participants, e.g. which languages were used with which family members, whether participants' parents were born in the UK, etc. The variation which was permitted included the following.

- Generation, indicating whether one, both or neither parents were born in the UK.[18]
- Degree of use with relatives/friends and in different topics.
- Frequency of Punjabi use in current life, e.g. every day, once per month, etc. Differences were carefully recorded.

[16] Dunn and Fox Tree's (2009) quick gradient bilingual dominance scale questionnaire was not available early enough to be incorporated into the current design which began pilot testing in 2009.
[17] In practice, ensuring that speakers have no receptive knowledge of Urdu is not possible, hence the possibility remains that a small number of participants may have had basic levels of receptive Urdu competence.
[18] Second generation here denotes the first generation of children born to migrants to the UK.

- Frequency of code switching, or general switching within the same conversation.
- Religion.
- Family country of origin, e.g. India, Pakistan, or Indian diaspora in Kenya.
- Perceived (self-reported) dominance on the first day of school.

Within these elements of variance, details of Punjabi language use were elicited for potential comparison with experimental data. Four specific measures were taken:

a. the frequency with which Punjabi and English were used in current adult life;
b. self-reported frequency of code-switching;
c. language use with different people/interlocutors;
d. language use in different spheres or topics of talk.

The questions on language use with different interlocutors totalled 32 and are plotted in Table 5. Each of the questions was measured on a five point scale with an additional not applicable option appropriate for cases such as a parent having died, participants having no partner, children or siblings, etc. The five responses available were: Only English / Mainly English / Both equally / Mainly Punjabi / Only Punjabi /Not applicable. It is acknowledged that responses to all questions on language use are based on respondents' subjectivities; Hakuta and Dandrea (1992) note that survey respondents' self-reports of language use can require interpretation in spite of being intended as objective measures.

Aside from the concerns about proficiency comparisons discussed in Section 2.7.2, a second reason for the focus of the survey was the view that fine-grained patterns of language use are an under-explored component of language control which may contribute to within-group variation among bilinguals.

The survey did not include a measure of language attitudes.

**Table 5 Measures of Language Use with Different Interlocutors**

| **Interlocutor** | **Childhood** *(Language used with this interlocutor in childhood)* | **Adulthood** *(Language used with this interlocutor in adulthood)* | **Productive** *(This interlocutor speaks X language to me)* | **Receptive** *(I speak x language to this interlocutor)* | **Total measures** |
|---|---|---|---|---|---|
| Mother | ✓ | ✓ | ✓ | ✓ | 4 |
| Father | ✓ | ✓ | ✓ | ✓ | 4 |
| Siblings | ✓ | ✓ | ✓ | ✓ | 4 |
| Elders | ✓ | ✓ | ✓ | ✓ | 4 |
| Best Friends | ✓ | ✓ | ✓ | ✓ | 4 |
| Other Friends | ✓ | ✓ | ✓ | ✓ | 4 |
| Colleagues | | ✓ | ✓ | ✓ | 2 |
| Neighbours | | ✓ | ✓ | ✓ | 2 |
| Partner | | ✓ | ✓ | ✓ | 2 |
| Children | | ✓ | ✓ | ✓ | 2 |
| | | | | | 32 |

## 3.5. Phoneme Monitoring Experiment

In phoneme monitoring tasks, participants judge, as quickly as possible, whether a phoneme is part of a picture name. Phoneme monitoring tasks instigate the process of top down lexical retrieval, begun by sight of a picture; in other words, in order to monitor whether a phoneme appears in a picture name, the participant must first retrieve the lexical item for that picture. This retrieval follows the process for word production set out in earlier chapters (see Section 2.2) proceeding through conceptual, syntactic and morphological layers of representation and lastly accessing the phonological contents of the word.

Phoneme monitoring is an online task. Online tasks measure 'unconscious and automatic response to language stimuli' and in general are posited to make low demands on working memory or metalinguistic knowledge (Marinis, 2010:3), though phoneme monitoring does contain at least an element of working memory. The picture remains until after the button has been pressed, so no working memory is required to maintain the lexical item. The only working memory requirements should be (a) to hold the phoneme in memory until the button has been pressed and (b) to remember which buttons represent yes and no, aided by a practice session and by large, bright labels on the appropriate keys. The paradigm also requires the participant to engage with the formal linguistic unit of a phoneme; this is explained at the start of experiment in simple terms.

The experiment consisted of a series of individual trials in which on screen presentation of a black and white line drawing was closely followed by an aurally-presented phoneme through headphones. Participants were asked to decide, as quickly as possible, whether the phoneme heard through headphones featured in the picture's English name. For example, on seeing a picture of a cat, a participant might be asked to decide whether /k/ formed part of the English word 'cat'. Responses were made by striking yes/no buttons on the keyboard. In all trials the target language was English, meaning that participants were instructed to respond only in relation to the English name of the picture.

Each of the experimental pictures, numbering 20, was presented on four separate occasions, a total of 80 trials, to ensure that positive and negative responses were balanced. Forty responses required a negative response, because the phoneme did not feature in the picture's English name, while 40 required a positive response because the phoneme did feature in the picture's English name.

Two types of negative response trial formed, respectively, a Related and an Unrelated condition. In the Related condition the phoneme heard through headphones was not part of the English picture name and was the onset of the Punjabi item name, i.e. was related to Punjabi. In the Unrelated condition the phoneme was not part of either the picture's Punjabi *or* English name, i.e. was unrelated to either. Both required a negative response.

Positive response trials, in which the phoneme did feature in the English word, were treated as fillers for the purpose of analysis. During design and testing they were termed English filler 1, the onset of the English word and English filler 2, a phoneme from elsewhere in the English word. Further fillers were used to reduce imbalance between the number of times different phonemes appeared in the experiment (see Section 3.5.3 below on phoneme selection). Conditions are presented below.

a. **Related Condition.** In this condition the picture was presented with a phoneme which formed the onset of its Punjabi name and which did not feature in its English name. For example, the picture below was presented with /b/ which forms the onset of Punjabi *billi*, but does not feature in English 'cat.' The correct answer in this condition was always no.

**i.** (e.g.  plus /b/ for *billi***)**

b. **Unrelated Condition.** In this condition the picture was presented with a phoneme featuring in neither its English nor its Punjabi name. For example, the picture below was presented with /v/ which features in neither 'cat' nor *billi*. The correct answer in this condition was always no.

i. (e.g.  plus /v/ featuring in neither cat nor *billi*)

**c. English 1 Fillers.** In these filler trials the picture was presented alongside a phoneme forming the onset of its English name and not featuring in the Punjabi name. The correct answer was always yes.

i. (e.g.  plus /k/ for 'cat')

**d. English 2 Filler.** In these filler trials the picture was presented alongside a phoneme featuring anywhere else in its English name, but nowhere in the Punjabi name. For example, the picture below was featured with /t/, which does not features at the end of its English name 'cat,' but not its Punjabi name *billi*. The correct answer in this condition was always yes.

i. (e.g.  plus /t/ from 'cat')

The Unrelated condition formed a baseline condition in the sense that Punjabi-speaking participants were expected to be able to dismiss the unrelated phoneme with ease and rapidity. The Related condition probed the possibility of interference from Punjabi to English; if the Punjabi lexical item was active at the lexeme level, Punjabi-speaking participants would be hearing a phoneme which

*did* in fact feature in an activated name for the picture. The task therefore would require them to ignore the activated but non-target language and answer negatively, a function of language control. An assumption in the experiment is that this increased processing demand is reflected by increased reaction times, as in previous studies indexing interference through increased reaction times (Colomé, 2001).

At +200ms after the picture appearance the phoneme was aurally presented. Given that earlier studies (Schriefers et al., 1990) have demonstrated that phonological effects occur when stimuli are presented at 0ms and +150ms, the phonological properties of the lexical items are expected to be active by the time the phoneme is presented. In this way the design may offer some protection against the possibility that the phoneme itself is activating the item, as speculated by Costa and colleagues 2006. However, the possibility that existing activation of the item is *reinforced* by the presentation of the phoneme is accepted; this is not considered a confound, as the likelihood of the phoneme presentation having created activation even in the absence of a picture is argued to be low.

As the task demand was to monitor English only, participants were expected to manage to ignore the active Punjabi word and return the correct response in most cases, i.e. respond negatively when the phoneme was not part of the picture's English name. Nonetheless, if Punjabi was activated, this extra requirement of control was expected to bear a processing cost, manifested in the additional time it would take to reject the phoneme. Therefore, the experiment tested for a difference in reaction times between the two negative conditions (Unrelated and Related). Longer reaction times for the Related condition than for the Unrelated condition were thus considered evidence that Punjabi lexical items were active and interfering. Any interference was expected to be apparent in group-level comparisons between group and condition.

The design was mixed, containing within-subject elements in that all participants underwent both experimental conditions as well as between-subject elements when analysed for group differences (monolingual/bilingual). All participants, monolingual as well as bilingual, completed all trials and conditions. The ***dependant variable*** was reaction time and the ***independent variables*** were condition (Related versus Unrelated) and group (Bilingual versus Monolingual). The *a priori* ***null hypothesis*** was that there would be no difference between the Related and the Unrelated conditions. Alternatively, a slower response latency for the Related condition among bilinguals would indicate that

participants were activating a non-dominant, non-environmental community language while performing tasks in a dominant, environmental language. As mentioned in Section 2.6, evidence of group level activation of Punjabi may be of some surprise. A mixed picture of results in which some English-Punjabi bilinguals show indications of interference while others do not needs to be carefully considered in the light of possible sociolinguistic explanations for differences; it was hypothesised that such a picture could support a view of bilingual processing as non-universal and more variegated according to finer-grained processing contexts than has been explored in most earlier studies. The differential between reaction times for the two conditions has been used to explore relationships with sociolinguistic variables, as a complement to group-level explorations; the method of calculation for the differential is explained in Section 4.2.

### 3.5.1. **Stimuli: Word List**

A word list suitable for the sample population was developed. The list was compiled of concrete nouns for everyday objects which were considered likely to form part of participants' vocabulary in both English and Punjabi taking account of the lack of literacy development in Punjabi and the expectation of a domestically-oriented vocabulary base. As a first step, an initial list of 105 concrete nouns was systematically compiled from a Punjabi-English dictionary based on standardised Punjabi (Goswami, 2002). As described in earlier chapters, there is considerable possibility of divergence between lexical items in Pakistani and Indian varieties of Punjabi. To minimise the possibility that the dictionary list would be skewed towards words in Indian varieties only, this initial dictionary list was then tested with a speaker of Punjabi from a British Pakistani family and items outside the speaker's vocabulary were eliminated from the list.

Further eliminations were made for the following reasons so that the list of words reduced in number: if words were vowel-initial (e.g. CAMEL/oth, EAR/kann); if difficult to depict in a black-and-white line drawing (e.g. milk, rice, almond, dates); if they began with the same initial consonant in both languages (e.g. BABY/bacha, SOAP/saaban, SNAKE/saap, ROPE/rassaa, BED/bishara); if the English word contained no second consonant with which to add a second 'yes' condition (e.g. EAR); if one of the experimental phonemes appeared in both words (e.g. BOOK/kutta); where the words were cognates (e.g. tomato, shop); or where there could be semantic relations with another

word in the list (e.g. head and hair). At the end of all these eliminations, a list of 30 words remained. All English words were nouns starting with a consonant that featured in the phonemic repertoire of both languages. To check these word pairings with real speakers, a simple translation task was mounted into an online survey platform, Survey Monkey. Twenty-five English-Punjabi bilinguals viewed the English words and typed a Punjabi translation. Words translated correctly by less than 18 speakers (72%) were removed, resulting in a final experimental word list of 20 items. Appendix 4 details frequency, concreteness and imageability ratings for the words obtained from the MRC Psycholinguistic Database.

#### 3.5.2. **Stimuli: Pictures**

Twenty accompanying pictures were selected to represent each item on the final word list. Pictures were black and white line drawings which were either taken from a published image set (Snodgrass & Vanderwart, 1980), drawn specifically for the experiment by the researcher, or taken from other copyright-free sources. Pictures for the 20 experimental items can be seen in Figure 4, below. Picture testing was conducted with 25 volunteers who named each picture in English. No pictures were changed as result of the testing. Digital images were prepared in bitmap form (BMP files) and were edited for uniformity of height to 5cm.

#### 3.5.3. **Stimuli: Phonemes**

Each of the 20 pictures appeared four times in two negative response trials and two positive response trials, accompanied by a different phoneme on each appearance. The distribution of phonemes in these 80 experimental trials is shown in Table 6, below, showing word pairs. Sixteen different consonants were used overall: /b, k, d, f, g, h, l, m, n, p, s, w, v, t, ʧ, ʃ/. No vowels were employed in the experiment.

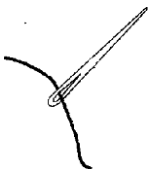
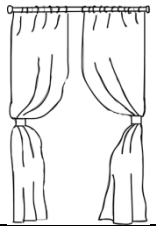
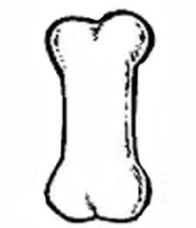
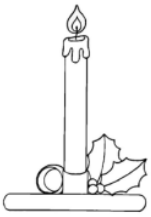
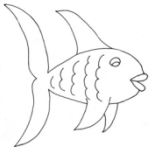
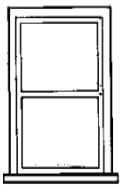
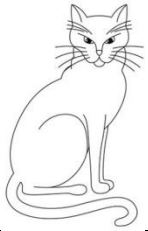
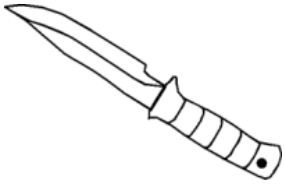
Consideration was given to the issue of plosives such as /p, t, k, b, d, g/ which form a single phoneme in English, but two separate phonemes in Punjabi depending on aspiration levels. As an example, the English voiceless bilabial plosive /p/ equates to two distinct phonemes for Punjabi speakers, unaspirated /p/ and aspirated /$p^h$/, while in Standard English aspiration levels will vary depending on the phonetic environment and are allophonic variants of the same phoneme (Ladefoged & Maddieson, 1996). Design endeavoured to avoid a potential confound in those trials in which

contrastive aspiration applied to the Punjabi picture name. For example, in the Punjabi trial relating to MONKEY/bandar, where the picture was presented with the phoneme /b/, would the picture fail to interfere with *bandar* if the aural phoneme was perceived to contain any trace of aspiration? In such a case, interpreting a lack of interference as non-activation of Punjabi where in fact it was caused by aspiration differences would be a misleading result. Including both aspirated and unaspirated productions of /b/ could not be the solution as this would signal Punjabi too strongly.

The choice to be made was between exclusion of plosives altogether, which unfeasibly reduced the number of potential words, or recordings produced with relatively neutral levels of aspiration. The latter path was taken and the English-Punjabi speaker was instructed accordingly. Phonemes affected by contrastive aspiration were recorded in the data so that analysis could assess the possibility that trials involving contrastive aspiration phonemes behaved differently to those not involving contrastive aspiration (see Section 4.4.8). Recordings were made for phonemes featuring in the experiment. As mentioned in Section 2.7.4, Punjabi has been subject to divergence, both in the region of origin and within the UK, and researchers have also argued for the emergence of a specifically British code which makes high usage of English lexis (Stuart-Smith, 1997, Stuart-Smith and Martin, 1999).

The purpose of the phonemes here was not to deliberately activate Punjabi representations but rather for the stimuli to be consistent with *either* English or Punjabi phoneme repertoires. The strategy for attempting to achieve this was the choice of speaker to record the phonemes. Phonemes were spoken by a male speaker from the target population: a British-born, monoliterate, male speaker of both English and Punjabi since infancy, aged 35. This design intention (of trying to avoid tipping the participants towards either English or Punjabi) arose from a concern to avoid artefactual influence over the mode in which participants completed the task. While such a goal is logical, it is problematic to achieve. As acknowledged in Section 2.7.4, it is highly likely that at least some of the participants would have been able to detect traces of the accent features of a British Asian speaker in the stimuli. If that were the case, it is expected that this knowledge may have shifted some participants further along the spectrum towards bilingual mode.

**Figure 4 Experimental Pictures**

| | | |
|---|---|---|
| Pillow  | Heart  | Fist  |
| Needle  | Curtain  | Spoon  |
| Bone  | Foot  | Bird  |
| Shirt  | Candle  | Fish  |
| Well  | Monkey  | Fly  |
| Flower  | Window  | Cat  |
| Watch  | Knife  | |

The difficulties of trying to create the conditions of monolingual mode in an experimental setting have been discussed in Sections 2.5.1 and 3.2 (which suggests that participants may have attended the experimental session partially in bilingual mode). The likely detectability of British Asian traces in the stimuli is another indication of the complexity involved. The safest assumption may be that, rather than indicating processing patterns when speakers are in strict monolingual mode, the experiment presented in this study may illustrate processing patterns when speakers are alert to the presence of the non-target language in the experimental context (through recruitment and auditory stimuli) but are not expecting to have to produce any Punjabi words themselves and are not in the presence of a co-speaker of Punjabi.

To ensure that participants would not be primed to associate a particular phoneme with either a positive or a negative response, potentially influencing their response, further filler trials were included to ensure that each phoneme had an equal number of positive and negative trials. Though each phoneme's appearance was equally balanced for positive and negative responses, it was not possible to ensure that all phonemes appeared an equal number of times across the experiment; additional fillers were added to reduce the discrepancy between each phoneme's number of appearances. While levelling the appearance of all phonemes to the same number would have been optimal, the number of fillers required to achieve this was considered disproportionately high. With these additional fillers the total number of trials was 136. Of these, the two negative experimental conditions (Related and Unrelated) were the only ones analysed (40 trials per participant).

Sounds were recorded as wave files on an Edirol R-09 portable professional audio recorder and then uploaded to WavePad audio editing software. Each sound file was edited to achieve 50ms of silence before onset of the consonant. Onset was determined visually by the beginning of the on screen sound wave in the editing software. There were 30-40ms of silence at the end of each sound. To test for intelligibility, the individual sound files were collated into a single MP3 file and played to 15 native English speakers. Volunteers repeated each sound so that recognition could be validated. As a result of testing, two sounds were re-recorded for clarity and volume adjustments were made to ensure even volume across the set.

One inevitable limitation of the study is that phoneme recordings were articulated in relative isolation; in the recordings they were completed with a brief schwa which was then edited to be of

minimal duration. Thus they do not sound identical to their realisations in the actual experimental words. In other words, the /b/ of the recordings will not precisely mimic the phonetic realisation of a /b/ in *billi* or in *bandar*. As no neutral presentation of a phoneme will ever sound exactly as it would within a word where it will be affected by its phonetic environment, the task demand necessarily requires some component of abstraction between the two. Error rates in the study do not suggest any difficulty in this regard, see Section 4.4.2. Delivery of the aural stimuli was made through headphones.

Choice of unrelated phonemes was constrained by experimental construction. For instance, pairings were avoided which caused a particular phoneme to be repeated too often over the experiment or caused an imbalance in the number of 'yes' and 'no' trials for a particular phoneme. To limit the phonetic proximity between the unrelated and related phonemes, selection ensured they did not overlap in more than one of the voice/place/manner distinctions (see Appendix 6).

The phonological distances between Related/Unrelated phoneme pairs was monitored through voice, place and manner, which may have left other aspects of phonological similarity unexplored. While a check was performed to ensure that all participants could well recognise and reproduce each phoneme before the start of the experiment, there can be no guarantee that the phonological distance between each Related/Unrelated pair is equal, and indeed it is highly unlikely that there is equidistance across all the pairs. This limitation is, however, one which impacts any psycholinguistic research using experimental stimuli to check for phonological effects. Those which use phonologically related orthographic distracters, pictures, or shapes are also relying on the presentation of an external stimulus to affect processing of phonological representations. As one among many possible examples, Colomé and Miozzo (2010) presented no words, letters or sounds. Their participants named pictures in Catalan while ignoring distracter pictures. Once translated into Spanish, the distracter picture names could be phonologically related or unrelated. Results showed no effect for the unrelated distracter items and a facilitation effect for phonologically related items. The pictures of phonologically related items, though not auditory, had therefore affected the processing of phonological representations, as would auditory stimuli. The issue of phonetic relatedness not being equidistance across all stimuli pairs, while acknowledged here, is not seen as critical or uncommon in the field. The most pertinent issue is that

participants can clearly detect the difference between related and unrelated items in the current study, as was demonstrated by correct responses in the pre-experiment trial.

### 3.5.4. **Experiment Construction**

The experiment was constructed in Superlab software, version 4.0, for use on a laptop. The response mechanism chosen was the keyboard, with keys [a] and [,] used for input for 'yes' and 'no' respectively. A green sticker containing the word 'yes' was placed over the [a] key and a red sticker containing the word 'no' over the [,] key. Participants were right-handed and striking the experimental 'no' key with their right hand. Wave form (.wav) files were uploaded for sound stimuli and bitmap image files uniformly sized at a height of 5cm. The experiment was piloted with ten native speakers of English (mentioned in Section 3.1.4), five of whom met the conditions for inclusion in the bilingual group and five of whom were English monolinguals. Following the pilot, two adjustments were made, the first to correct a malfunctioning trial and the second to re-record one of the experimental sounds. After the pilot, four versions of the experiment were created, labelled Orders A, B, C, D, available in Appendix 3. Trials were presented in a different order in each of the four versions so that results would not be attributable to the sequence, with a possible practice effect occurring for later trials.

**Table 6 Word Pairs. (English 1 and 2 signify trials in which the phoneme is part of the picture's English name and the correct trials response is 'yes'. These trials were not included in experimental analysis.)**

| Word Pairs | Related *(NO)* | Unrelated *(NO)* | English 1 *(YES)* | English 2 *(YES)* |
|---|---|---|---|---|
| PILLOW/sarhaanaa | s | v | p | L |
| NEEDLE/sooee | s | v | n | D |
| BONE/haddee | h | l | b | N |
| SHIRT/kameez | k | n | ʃ | T |
| WELL/khooh | k | t | w | L |
| FLOWER/phul | p | d | f | W |
| WATCH/gharee | g | l | w | ʧ |
| SPOON/chamach | ʧ | d | s | N |
| BIRD/Chiree | ʧ | n | b | D |
| KNIFE/chhuree | ʧ | w | n | F |
| HEART/dil | d | w | h | H |
| CURTAIN/purdah | p | ʃ | k | T |
| FOOT/puer | p | g | f | T |
| CANDLE/mombattee | m | w | k | D |
| MONKEY/Bandar | b | f | m | K |
| WINDOW/baaree | b | t | w | D |
| CAT/billee | b | v | k | T |
| FLY/makkh, makkee | m | v | f | L |
| FISH/mach, machee | m | l | f | ʃ |
| FIST/mutth | m | w | f | T |

### 3.5.5. **Procedure**

At the experiment session, after signing the consent forms and completing the survey participants were instructed as to the phoneme monitoring paradigm. Three picture-phoneme examples were given verbally to introduce the paradigm, following which participants read through standard written instructions (Figure 5). Three further steps followed before the experiment was begun. First, participants listened to the MP3 file containing all phonemes and repeated each one as a check on recognition. Secondly, to ensure they all associated the same name with each picture, they looked through a complete set of all pictures with their English names printed beneath. Finally they practised

using the response keys without looking down at the keyboard. Participants were assigned to one of the four order versions described in 3.5.4, with an equal male/female split for each version.

The experiment was then begun. Participants sat in a quiet room in front of a laptop wearing headphones. The first screens of the experiment were instructions, which the subjects could move through at their own pace by key presses. A final instruction screen warned that pressing the 'yes' key would start the experiment. There were 136 trials in total, consisting of 80 trials featuring the 20 experimental pictures (four appearances each, of which only the two 'no' trials were analysed) and 56 fillers containing other pictures. As mentioned in section 3.5.3, these additional fillers help to reduce disparities in the number of times each phoneme occurred in the experiment.

Each individual trial consisted of four events:

a. An inter-stimulus interval (ISI) of 500ms
b. A 1500ms fixation point in the form of '+'
c. A picture
d. After the picture had been onscreen for 150ms the sound file played; as each sound file was preceded by 50ms of silence before the onset of the consonant, this represented an SOA of +200ms.

Response latencies and error data were recorded through Superlab. After completing the experiment, participants named each of the 20 experimental pictures in Punjabi. Those pictures which could not be named by that participant were noted and excluded from analysis for that individual. Finally, the workings of the experiment were explained to any participants who wished to know and they were asked whether they would like to have individual and/or group results at a later date.

**Figure 5 Written Experiment Instructions**

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## Instructions for Experiment

1. In each trial you will see a cross followed by a simple picture, like this one.
2. Think of the picture's name (bed).
3. At the same time, you will hear one sound, like 'b'.
4. Do you think the sound 'b' is part of the word for this picture (bed)? (Answer = ***YES***)
5. What about the sound 'd'? (Answer = ***YES***)

***How to answer*** - You will have your hands ready on the **YES** and **NO** keys to answer (so that you don't need to look down at the keyboard). You need to answer as quickly and as accurately as you can and your response will be timed in milliseconds.

***Some tips*** -
The pictures are all common objects, never actions or complicated words.
The sound might appear at any part of the word, even the end.
Try to forget all about letters and think of only the sound - 'dogs' has a 'zzz' sound in it despite the s and 'knife' does not have a 'k' sound.
You will see each picture more than once.

***What next?*** –
Before the experiment starts there is a quick practice session with some pictures, and a keyboard practice so you can get used to answering YES or NO without looking down.

***What if I need to pause?*** –
The experiment preferably runs without a pause, but if you need to break for a moment (e.g. to sneeze!) press the Escape key (ESC). The programme will ask if you want to exit the experiment. Do not click Yes - just leave the message on the screen until you are ready to continue and then click No to go back in.

The experiment itself takes 15-20 minutes.

***You are free to withdraw at any time without giving a reason.***

**About the Researcher**
Contact: Joanna John, c/o Gabriella Rundblad, Centre for Language, Discourse and Communication, Department of Education and Professional Studies, Kings College London, Franklin-Wilkins Building, Waterloo Bridge Wing, Waterloo Road, London SE1 9NH. If you wish to receive a copy of the research report please email at joanna.john@kcl.ac.uk. It is up to you to decide whether to take part or not. You are free to withdraw at any time and without giving a reason. If this study has harmed you in any way you can contact King's College London for further advice and information: Dr Gabriella Rundblad, Lecturer in Applied Linguistics, Department of Educational and Professional Studies email gabriella.rundblad@kcl.ac.uk.

# Chapter 4. Results

This chapter presents the main results of the study. The interviews with a sub-sample of bilingual participants are covered in Section 4.1, beginning with the purpose and limits of the interviews (Section 4.1.1), procedure (Section 4.1.2) and reporting of the key aspects of language use to emerge from the interviews (Section 4.1.3). Section 4.1.4 describes how interview analysis informed the use of survey data to explore variance in the experimental data, specifically describing which aspects of language usage were focussed on.

The remainder of the chapter is then focussed on quantitative results. The approach to statistical analysis is first described in Section 4.2. Survey data are next presented in Section 4.3. This begins with descriptives (Section 4.3.1), covering such aspects as the proximity within which the two languages are used, the spread of Punjabi use across topics, each language's frequency of use and patterns of usage with different interlocutors in childhood and adulthood. Section 4.3.2 presents the Principal Component Analysis performed to explore variance within interlocutors. This is followed by description of the set of aggregated interlocutor variables developed to feed into statistical analysis of experimental data in Section 4.3.3. Analysis of experimental data is next provided in Section 4.4. A detailed account of the treatment and preparation of experimental data is given, including outlier analysis (Section 4.4.1), error rates (Section 4.4.2), participants' knowledge of the experimental Punjabi words (Section 4.4.10) and distribution of reaction time data (section 4.4.11). Section 4.4.12 moves on to the group analysis for the phoneme monitoring experiment, using a mixed model ANOVA to examine differences between conditions and groups and group by condition interaction. Analysis then turns to within-group bilingual variance (Sections 4.4.13-4.4.16).

## 4.1. Interviews

This section sets out the interviews conducted with a subset of bilingual participants.

### 4.1.1. Purpose and Limits

The role of interviews was to inform how survey data would be used for within-group variance in experimental data. Within-group bilingual variance in experimental data was explored in relation to a set of predictor variables (set out fully in Section 4.3.3); the data source for all predictor variables was the language survey completed by all bilingual participants (described in Section 3.4) and these interviews with ten of the bilingual participants served only to inform the method for selecting and re-aggregating predictor variables from the survey. The aggregated survey variables were later tested for their predictive ability against the differentials between reaction times in experimental conditions using regression analysis (Section 4.4.15). A theoretically informed aggregation of the survey data was preferred over an attempt to utilise survey data in a regression analysis in its raw form.

In line with the view of Kroll and colleagues (2012:245) that the remit of psycholinguistics concerns itself with understanding the architecture of the language system rather than with understanding particular linguistic populations, the interviews served only the purposes of psycholinguistic analysis, specifically research question 2 of the current study (see Section 2.7.1) on the potential influence of language usage on processing. While the interviews do not form a sociolinguistic work, they do seek more in-depth information on such areas as habitual language choice, topical regulation and domains and could thus be regarded as sociolinguistically-informed.

Interviews were conducted after participants had undertaken the experiment, at a later session, but prior to the completion of experimental analysis. Interviews took place in tandem with experimental data entry, but not in tandem with any statistical analysis – the interview findings emerged before experimental findings were known and were not influenced by experimental results. The interviews were not used to confirm or dismiss the experimental results and do not represent triangulation in the sense of using two methodological approaches in order to arrive at convergent results – as the main research question of this study concerns *un*conscious processing, upon which interview informants cannot directly comment, interview data cannot address the research questions of this study beyond providing accounts of surface tendencies in language behaviour and choice. The

primary purpose of the interview data was not, therefore, for informants to account for or explain their own unconscious language processing, or to confirm experimental findings.

### 4.1.2. Procedure and Coding

Section 3.1.3. describes the ten bilingual participants who were interviewed and Table 4 provides key characteristics of the interview informants. The interviews were all conducted by the author, who was known to participants to be a non-speaker of Punjabi.

The interviews were semi-structured in that questions were based on pre-defined question clusters, but were loosely and informally posed; participants were permitted to pursue their own directions of response. Question clusters were directed to points which could be hypothesised to impact on processing, as outlined in Section 2.5: language choice, attitude, topical regulation, domains and code-switching (it should be noted that attitude was not included in the survey). Some other profile aspects captured by the survey were not felt to require further qualitative exploration, such as frequency of use and age of acquisition, and thus did not feature in interview questions. Question clusters included the following.

- A description of the home environment, family members living there, and an overview of language use within the home. This cluster led to profiling of usage with different interlocutors.
- Code-switching, including its frequency and attitudes to code-switching.
- Places and situations in which the informant perceived it would be appropriate and inappropriate to speak Punjabi/English.
- Whether there were topics an informant would find easier or more difficult to talk about in Punjabi, or topical preferences for Punjabi use.
- Attitudes to Punjabi and the relationship between Punjabi and other languages the informant may know or encounter.

Interviews were recorded using a portable digital recorder and then transcribed.

As such a small number of participants did not necessitate the use of qualitative research software, some initial textual analysis took place prior to use of software. At a later point the transcripts were uploaded as text to qualitative research software (NVIVO 10.0) to facilitate and better organise coding.

Exploration of the data was mainly top-down, focussing on the pre-specified areas of interest mentioned above. Areas of pre-defined interest were defined as top-level nodes within NVIVO. These pre-specified, top-down NVIVO nodes included: topic; a range of interlocutor types (mothers, fathers, elders, siblings); switching; 'Punjabi is Appropriate;' and 'Punjabi is Inappropriate.' The coding process also remained open to the emergence of new themes which could potentially impact on processing. Some nodes of analysis which were not pre-defined included: marriage, mono-literacy, emotion, school, secrecy, humour and food and identity. With the exception of domain, these themes were largely not pursued further in the statistical analysis, mainly due to the absence of related survey data for all 64 bilinguals.

The next section reports some key aspects of language behaviour of potential relevance to processing arising from the interviews.

### 4.1.3. **Interview Results**

#### *Code-Switching*

Though informants were asked about code-switching, a significant limitation of the interview data is that only participants' perceptions of code-switching can be captured; the data cannot distinguish between, for instance, intra-sentential code-switching, tag switching and simple borrowing. Given these limitations, the only indication gleaned was that switches were perceived to be frequent and were seen as something that 'just happens'. Analysis was restricted therefore, with very limited capacity by participants to comment in detail on switching behaviour.

#### *Topical Regulation*

Evidence for topical regulation was limited to three areas: medical matters, work/study and food. Informants cited medical language as an area they could only discuss in English (or in Punjabi with heavy English borrowing). Escorting parents to the doctor, or, for one informant, the first experience of

pregnancy, involved specialist terminology for which informants lacked Punjabi lexis. Speakers struggled to explain their work and academic study in any detail in Punjabi. Some participants reported these tendencies as affecting the broad arena of business and employment ('if it's something to do with business or management, stuff like that, it would be hard telling them about that in Punjabi,' Informant 8).

Speakers attributed these restrictions to limitations in their own breadth of Punjabi vocabulary, expressed either as a difficulty of retrieval ('I can't find the words in our language sometimes to explain it to them,' Informant 9), or a lack of knowledge ('If it's something more complicated, I wouldn't know how to do that,' Informant 8). These limitations were perceived to apply to their parents' generation also, due to the structure of parents' formal educational and home language use in Pakistan, or to the development of Punjabi itself. Informant 2 described mono-literacy as a glass ceiling on her mother's Punjabi proficiency and felt Punjabi's ability to deal with science and technology was under-developed. These accounts suggests that, even for speakers educated in Pakistan, the lack of formal instruction through the medium of Punjabi may delimit lexical breadth and the type of words known in Punjabi, with the scope of Punjabi being limited to those topics discussed in day to day life. In broad terms, such topical limitations fit within Fishman's (1965:72) account of motivations for topical regulation both in that 'they (and their interlocutors) may lack the specialised terms' but also in that a language itself 'may currently lack as exact or as many terms for handling topic x as those currently possessed by language X.' Whether these limitations of the language are real or perceived is not explored here, but the usage patterns resulting from this perception of Punjabi as unsuitable for technical talk are noted.

Where talk about medical, technical and work issues required English, the reverse was true of talk about food which strongly associated with Punjabi. One speaker contrasted her description of the difficulties of discussing academic work in Punjabi with the example of food, concluding 'food ***is*** Punjabi.' The data cannot determine whether food associated so strongly with Punjabi due to a requirement for specialized vocabulary for cooking techniques, equipment, etc., or was simply related with the domain in which discussion of food most commonly took place.

Of the three areas mentioned (medical talk, work talk and food), the survey had collected data on only one (talking about work). The capacity for the survey data to measure topical regulation was therefore felt to be limited, although the interviews did provide some evidence for a level of topical regulation in their language behaviour.

### *Interlocutor-Driven Language Choice*

Most informants lived either within the same household as their parents or within close travelling distance of family. Through questions about language use with family members and friends, a profile of use with different interlocutors was obtained.

#### *Mothers*

All ten participants reported their mother's language usage to be heavily Punjabi-dominant, even where mothers had some proficiency in Urdu. Most speakers' mothers had received little or no English language instruction in the UK or Pakistan and some had received no schooling at all. Mothers were described as having considerably lower English proficiency than fathers, whose English proficiency was reportedly developed by their employment outside the home (no interview informant reported their mother to be employed outside the home). A common description of mothers' proficiency was that it was just enough English 'to get by,' though some speakers sensed a reluctance to use English on the part of their mothers and suspected that there might be more English proficiency than was revealed. Informant 2 commented, 'When we're not there, she does get by, she can do it all – but when we're there she relies on us.' Mothers' Punjabi dominance also had the effect of pulling some plenary family interactions towards Punjabi in order that mothers would not be excluded.

#### *Fathers*

Most informants reported that English featured more in their interactions with their father than their mothers. This pattern was seen by speakers as having originated in their fathers first addressing them in English, rather than having been instigated by children. Fathers were seen to more proficient in English, which some participants thought was accounted for by their employment outside the home.

### *Siblings*

Language use with siblings was mixed and partly driven by who else was present. Mixing languages with siblings was reported to be very common, even if no parents or elders were present. Triggers for a language switch were mainly thought to be the entry of a new interlocutor who could poorly follow English or for whom English was less appropriate. The current study did not record sibling order, but some accounts suggested that it contributed to Punjabi use in that those lower down in the birth order had increased use of English with siblings, while first-born children were bound by the language patterns of the adults until they began school (Guo, Misra, Tam, & Kroll, 2012, provides an example of a sibling order effect on language use).

### *Elders and Respect*

Language use with elder relatives, including not only grandparents but any older Punjabi-dominant relative or close family friend who might live in another house, was reported to be predominantly Punjabi. This category of interlocutor, hereafter referred to simply as elders, was not delineated by an absolute age but rather by age relative to the informant (an informant aged 19 included a 30-year-old sister-in-law from Pakistan in this category). Elders' own language use was predominantly Punjabi, with some additional use of Urdu. At first sight, accounts appeared to suggest that it was elders' lack of English which caused switches to Punjabi to be instrumentally required. However an ambiguity emerged from the accounts about the true level of English proficiency among elder interlocutors. As with accounts of mothers, informants were not always sure how well their elder relatives could speak and understand English. Some participants reported humorous suspicion about their grandmothers' ability to follow conversation in English. All informants strongly confirmed the social convention of Punjabi use with elders, with very rare use of English to elders. Accounts were consistent with switches into Punjabi for elder interlocutors as not necessarily being compelled solely by elders' lack of English, but having possibly become a habitual language choice; for similar accounts, see Fishman (1965).

Intertwined with this pattern was the view that Punjabi was seen to fulfil cultural preferences for respect marking in that (a) speaking Punjabi was a respectful thing to do in itself and (b) Punjabi as a language contained more linguistic mechanisms for marking respect. No particular argument is made

here for a direct impact of politeness strategies on language processing (neither is one ruled out), however the data suggested the possibility that respect requirements could make a contribution to habitual language choice and so to the development of a domain. Linguistic politeness conventions utilised in South Asian languages include: marking kinship and fictive kinship, the referent honorific (for a description of both terms, see Levinson, 1983), using plurals in second and third person references to a single person, name avoidance and the honorific particle *–ji* (e.g Bhatia, 1993). Though the proficiency of mothers, grandparents and other elders was often low, informants placed a stress on respect which went beyond instrumentalism, suggesting that it was an important driver of language choice in its own right, in which elders as an interlocutor category were strongly implicated.

### *Marriage, Children and the Competition of Urdu*

Data from the small number of informants who were married (four) were not suggestive of a particular relationship between entering marriage and Punjabi usage patterns, beyond the obvious statement that Punjabi use may increase or decrease depending on partner choice. Some participants discussed transnational arranged marriages and the transmission of attitudes to Punjabi from Pakistan through brides and in-laws; in these accounts Urdu created a pressure against Punjabi use in the home because of its higher prestige.

Informants were asked about use of Punjabi with children and some responded with accounts of their own childhood. These accounts indirectly raised a related issue of speakers feeling that entering school had triggered a downturn in their Punjabi use. School was pinpointed by a number of adults as the place where they learned to 'keep the Punjabi below and keep the English at the top' (Informant 9). No specific rules against Punjabi use were recalled, participants simply felt a cultural expectation to keep Punjabi out of the school environment. One parent who used mainly Punjabi with her child ceased doing so due to teachers' concerns; the mother significantly reduced home use of Punjabi with an impact on parents' usage levels following. Though of interest, this issue was not directly tied to variance within participants' adult language processing.

### *Attitudes to Punjabi*

Informants variously described Punjabi as common, harsh, agrarian in origin and best suited for rough humour and imperatives. It was frequently contrasted with Urdu, described as elegant, official,

educated and 'posh,' though possibly also pretentious. Some participants switched into Punjabi for swearing and emphasis, or when angry.

***A Home/Family Domain***

Fishman (1971) cautions that care is required in establishing domains and the data presented here are not based on extended participant observation of natural language use, but reported use of language in a single interview. However, the description of language use above builds towards a profile which is consistent with a 'home/family' domain in which informants' Punjabi plays its strongest role. The importance of elders who live beyond the household and who may only be indirectly related or entirely unrelated leads to the suggestion that the proposed domain extends a little way beyond a simple 'home' territory. A speculated outer boundary for the domain might coincide with use of fictive kinship terms, i.e. with non-related elders whom the speaker might address as uncle for politeness sake. No claim is made that Punjabi is the dominant language in such a domain, as mixing with English is widespread; rather the emergent picture suggests that, of the full array of an individual's Punjabi usage, the greatest single proportion may occur within the 'home/family' domain proposed here.

***Interlocutors versus Space***

To interrogate further the possibility of a home/family domain, attention was paid to (a) the extent to which Punjabi was viewed to be more appropriate in home/family settings than outside them and (b) whether the delineation was demarcated as much by physical spaces as by interlocutors. The issue of appropriateness was explored through questions which did not proposition the idea of a home/family domain, but more openly asked whether there were 'times or places' in which using Punjabi felt 'more appropriate or less appropriate.'

Speakers saw home and family contexts as the key environment for Punjabi. The importance attributed to Punjabi use in cross-generational gatherings of extended family, wherever they occurred, suggested that a domain for home and familial use might not be literally restricted to the participant's physical household, but apply to a somewhat wider social network of Punjabi speakers. Failure of children to speak Punjabi while attending such gatherings was described as a cause of embarrassment for parents.

Conversely, Punjabi use outside this extended home/family domain, taking place in public spaces, was considered to be mostly inappropriate, with final judgement on appropriateness made according to who else was present. The presence of English monolinguals raised politeness dilemmas; informants absorbed a view that use of Punjabi in public spaces and in the company of non-Punjabi speakers (even a single non-speaker) could contravene politeness or lead to the perception of secretly discussing non-Punjabi speakers.

School and work both emerged as physical spaces in which Punjabi use was firmly inappropriate. Outside the domains of school and work however, informants resisted any proposition of physical space as determining language choice on a simple basis. Where the physical space had no specified proscription against Punjabi, as did work and school in participants' view, interlocutors and surrounding hearers were seen to be more important than spaces. Mosques as physical spaces were not thought to weight choice towards Punjabi. The importance of people over space was consciously expressed in some cases, with informants describing interlocutors as a 'trigger' (not a term introduced by the author) for Punjabi use.

Consideration was given to how this hypothesised domain might be differentiated from the broader Punjabi speaking community. One differentiation appeared to be interlocutor category, in that not all Punjabi speakers presented the same level of inducement to switch language. Another was evidence for hesitancy in speaking Punjabi when outside the home/family domain, even with interlocutors who would normally motivate a switch.

### 4.1.4. Key Language Use Aspects Feeding in to Survey Analysis

Though potentially important, language attitudes could not be operationalised as a predictor variable as there was no corresponding survey measure, as specified in Section 3.4. While interview data could not differentiate between types of switching or offer detailed insight, it did indicate the frequency of switching and on this basis switching was included as an aspect to be covered by predictor variables. Topic was included as a predictor variable on the basis that some moderate contribution to the delineation of Punjabi usage from topic was evidenced in interviews.

The two most noteworthy features of usage consistently raised by the participants related to interlocutors and domains. Accounts suggested that home/family, work and school could operate as

three distinct domains. The speakers' own home, as well as their family networks, emerged as the core spheres of their Punjabi use and a home/family domain for this population is postulated to extend beyond the physical confines of a participant's house to the wider family network, encompassing the homes of relatives and family friends as well as larger social gatherings.

The interviews explored the possibility of spatial elements in activation and found little evidence for this; far greater importance was placed on interlocutors as drivers of language choice. The presence of particular interlocutors from the home/family domain appears to, in many circumstances, override the physical location in driving language choice, though not where there is a significant presence of non-Punjabi speakers and not in domains that strongly proscribe against Punjabi (suggesting that domain could over-ride interlocutor in determining choice). Within the home/family domain, speakers' language varied by interlocutor. This tendency, in combination with speakers' stress on the importance of interlocutors and the fact that the survey contained use-by-interlocutor measures, led interlocutors to be designated as important for any analysis of bilingual variation.

Work was differentiated as a domain in which Punjabi was inappropriate, suggesting the processing possibility that the language system was typically unlikely to prepare Punjabi for use while the speaker is at work, with a trigger for activation possibly occurring upon entry to the home/familial domain. School emerged not only as an English monolingual domain but also as a trigger for declining levels of Punjabi use, with the potential for negative impact on language maintenance. While the view of domains provided by these accounts is broad and not definitive, they are broadly suggestive of differentiation between the three domains described (school, work and home/family).

Moving forward to survey analysis, interlocutors were selected as a key area of analytic interest for the development of predictor variables. Other areas selected were: switching, frequency of Punjabi use and spread of Punjabi across topics. The operationalization of predictor variables is described in Section 4.3.3.

The remainder of this chapter concerns quantitative results of the study, starting with a description of the approach to statistical analysis.

## 4.2. Approach to Statistical Analysis

Initial analysis included exploration of reaction time differences between the two conditions in each group through mixed ANOVA, using group (monolingual/bilingual) as a between-subjects factor and condition (Related/Unrelated) as a within-subjects factor. No analysis was performed on fillers, including all those representing 'yes' responses. Outlier and error analysis are described in Sections 4.4.1 – 4.4.8. Based on the *a priori* hypothesis, a significantly slower response rate for the Related condition in the bilingual group was taken as evidence that non-target phonological knowledge was causing interference among bilingual participants. As this between-group approach examines bilinguals only at a group level, possibly flattening different activation patterns within the group, further within-group, *post hoc* exploration also included the anticipated possibility of variance with the bilingual group (as argued above, see Grosjean 1998).

The specifics of *post hoc*, within-group analysis were planned only partially at the outset; the intention to explore within-group variation for relationships with sociolinguistic usage patterns was firmly part of the research design, as was use of an individual participant's differential (explained further below in the current sub-section) as dependent variable. The specifics of how sociolinguistic usage patterns would be operationalised was deliberately open so that it could be informed by interviews with participants; the survey, described above in Section 3.4, was designed to capture a number of sociolinguistic usage variables which could potentially interact with activation states (use of different languages for different topics, with different interlocutors, etc.), while analysis of the interview data then informed how survey variables were prioritised and aggregated. For this reason, analysis of the interview data was undertaken before experimental analysis.

The reasoning behind using a reaction time differential between conditions is as follows. Activation and inhibition are unconscious processes (Paradis, 2004). However the task demands of the experiment also require at least some conscious monitoring in that it necessitates holding the phoneme in working memory while a check is performed. This check takes time to complete. As the absolute speed with which that check is carried out may be subject to individual differences, the differential in reaction times between the Related condition (in which the phoneme relates to the Punjabi name for the picture) and the Unrelated condition (in which the phoneme is unrelated to either the English or

the Punjabi name for the picture) is of considerable interest; all other things being equal, a single speaker could be expected to achieve the task equally fast across trials, while the same cannot be said for comparisons of two different speakers. Thus, rather than consider only absolute reaction time values for each condition, a value for individual's differential in mean reaction times for each condition was also calculated.

The differential value for each participant was calculated by subtracting the mean reaction time for the Related condition from the mean reaction time for the Unrelated condition (Unrelated – Related = Differential). A negative value for the differential indicated that the Related Condition was slower; slower reaction times in similar experimental conditions have previously been interpreted as evidence of interference (e.g. Colomé, 2001) and thus activation of the non-target language.

Initial analysis of the survey was undertaken mainly through descriptive statistics. Survey and experimental data collection were undertaken first, simultaneously in a single session with participants. Interview analysis was undertaken while the survey and experimental data were at entry/data cleaning stage, i.e. knowledge of the results of the experiment in no way informed the analysis of interview data. Following this, quantitative analysis of the experiment was undertaken.

## 4.3. Survey of Language Use

Demographic data on participants captured from the survey, such as age, faith and education levels, were reported in Section 3.1. The following sub-sections cover survey data on language usage, including the descriptive results and the re-coding of data to provide predictor variables feeding in to experimental analysis.

### 4.3.1. Descriptive Results

Exploration of data from the survey proceeded initially through descriptive statistics. Table 7 and 8 suggest that, for more than half of the participants, both languages are used in close temporal proximity to one another, each featuring in daily life and co-occurring within the same conversation on a daily basis; 59% of participants use Punjabi on a daily basis and code-switching is used daily by just under half of bilingual speakers. Almost 90% of bilinguals use Punjabi once per week or more in current (i.e. adult) life. There was some variation in the sample in that approximately a tenth of bilingual

speakers used Punjabi once per month or less. An exploration of the eight individual participants who spoke Punjabi less than once per month indicated that seven of them were married to monolingual Anglophones and one lived at considerable distance from her family.

**Table 7 Language Use: Frequency of Punjabi Use**

| Modality | Every day | | 4-5 times a week | | 2-3 times a week | | Once a week | | Once a month or less | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % |
| Hear Punjabi | 39 | 61% | 5 | 8% | 4 | 6% | 9 | 9% | 7 | 11% |
| Speak Punjabi | 38 | 59% | 4 | 6% | 4 | 6% | 10 | 16% | 8 | 13% |

**Table 8 Language Use: Proximity of Use**

| Proximity of Use | Every day | | 4-5 times a week | | 2-3 times a week | | Once a week | | Once a month or less | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % |
| Use both languages in the same day | 38 | 59% | 5 | 8% | 3 | 5% | 5 | 8% | 13 | 20% |
| Use both languages in same conversation | 33 | 52% | 5 | 8% | 6 | 9% | 7 | 11% | 13 | 20% |
| Code-switch | 30 | 47% | 4 | 6% | 8 | 13% | 7 | 11% | 15 | 23% |

**Table 9 Language Use: Topics**

| Domain (Topic) | English | | Punjabi | | Can't tell or N/A | |
|---|---|---|---|---|---|---|
| | n | % | N | % | n | % |
| Familial & domestic talk | 26 | 41% | 21 | 33% | 17 | 27% |
| Discussing work | 45 | 70% | 5 | 8% | 14 | 22% |
| Current affairs | 44 | 69% | 6 | 9% | 14 | 22% |
| Prayer and religious talk | 14 | 22% | 28 | 44% | 22 | 34% |
| Gossip | 28 | 44% | 12 | 19% | 24 | 38% |

Table 9 reports the degree to which participants' conversations with other Punjabi speakers employ Punjabi rather than English in different topic areas. The column reporting English captures both 'Only English' and 'Mainly English' response categories, with the same approach used for the Punjabi column. English was perceived to dominate discussion about work and news/current affairs; only 8% and 9% respectively reported that Punjabi dominated conversations about these topics. Punjabi featured more in talk of a domestic/familial nature and in faith-based discussion than other topics, dominating domestic talk for a third of participants and faith-based talk for almost half. Almost a fifth of respondents also reported a greater role for Punjabi in gossip. These data do not take account of the differing frequencies with which each of these topics are discussed and it must be assumed that topics such as religion, though involving more frequent use of Punjabi than English, are likely to be less

frequently discussed than the house-management talk that was intended in the domestic question. Any potential impacts on language processing arising from the spread of topics would therefore be complex and mitigated by general frequency. Overall, responses suggest a picture in which Punjabi dominates few categories of conversation, with its realm restricted to a smaller number of functions centring on domesticity, faith and social gossip. A final comment on the data in Table 9 is that even those topics in which English dominates may still feature partial Punjabi use due to the prevalence of different forms of switching.

**Table 10 Language Use: Childhood Interlocutors**

| Childhood Interlocutor | Only English | | Mainly English | | Both Equally | | Mainly Punjabi | | Only Punjabi | | N/A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % | N | % |
| Mother[1] | 1 | 2% | 4 | 6% | 7 | 11% | 15 | 23% | 37 | 58% | 0 | 0% |
| Mother[2] | 2 | 3% | 11 | 17% | 5 | 8% | 28 | 44% | 18 | 28% | 0 | 0% |
| Father[1] | 4 | 6% | 9 | 14% | 14 | 22% | 19 | 30% | 16 | 25% | 2 | 3% |
| Father[2] | 7 | 11% | 10 | 16% | 14 | 22% | 19 | 30% | 12 | 19% | 2 | 3% |
| Siblings[1] | 30 | 47% | 22 | 34% | 8 | 13% | 2 | 3% | 0 | 0% | 2 | 3% |
| Siblings[2] | 31 | 48% | 20 | 31% | 8 | 13% | 2 | 3% | 1 | 2% | 2 | 3% |
| Elders[1] | 0 | 0% | 1 | 2% | 3 | 5% | 11 | 17% | 49 | 77% | 0 | 0% |
| Elders[2] | 0 | 0% | 2 | 3% | 3 | 5% | 11 | 17% | 48 | 75% | 0 | 0% |
| Best Friends[1] | 46 | 72% | 15 | 23% | 2 | 3% | 1 | 2% | 0 | 0% | 0 | 0% |
| Best Friends[2] | 46 | 72% | 15 | 23% | 2 | 3% | 1 | 2% | 0 | 0% | 0 | 0% |
| Other Friends[1] | 53 | 83% | 9 | 14% | 2 | 3% | 0 | 0% | 0 | 0% | 0 | 0% |
| Other Friends[2] | 53 | 83% | 9 | 14% | 2 | 3% | 0 | 0% | 0 | 0% | 0 | 0% |

[1] Receptive
[2] Productive

An important function of the survey was to map the relative weighting of English and Punjabi with different interlocutors in the bilinguals' lives (Tables 10 and 11) in order to be able to explore potential processing implications. Most participants reported that, during childhood, their mothers addressed them either through Punjabi exclusively (58%) or through an English/Punjabi mixture in which Punjabi dominated (23%). Responses reveal some modal asymmetry in that participants responded with more English than their mothers used: for instance, 33% of participants spoke Punjabi exclusively to their mothers compared to 58% of mothers using only Punjabi to address their children. In childhood, participants' fathers generally employed less Punjabi than participants' mothers - 25% of fathers used Punjabi exclusively and most other fathers used a mixture of the two languages.

Data suggest that in childhood interactions between participants and their elder relatives there is a tendency (77% receptive/75% productive) for exclusive Punjabi use. The data on childhood

interlocutors is suggestive of a pattern in which language use shifts on a generational basis with Punjabi dominating in conversations between participants and their elders, having a strong position in mother-child talk, then declining in peer level conversations between siblings and friends. This is a synchronic snapshot of inter-generational language use rather than a diachronic indication of change over time, see Saussure (1983) for definitions. In adulthood the pattern of differentiation across generations persists for many participants; with elders, for instance, Punjabi is used exclusively by 67% of participants in their adulthood.

**Table 11 Language Use: Adult Interlocutors**

| Adult Interlocutor | Only English | | Mainly English | | Both Equally | | Mainly Punjabi | | Only Punjabi | | N/A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % | N | % |
| Partner[1] | 20 | 31% | 9 | 14% | 6 | 9% | 6 | 9% | 2 | 3% | 21 | 33% |
| Partner[2] | 21 | 33% | 10 | 16% | 5 | 8% | 6 | 9% | 1 | 2% | 21 | 33% |
| Children[1] | 13 | 20% | 10 | 16% | 1 | 2% | 3 | 5% | 2 | 3% | 35 | 55% |
| Children[2] | 13 | 20% | 10 | 16% | 1 | 2% | 3 | 5% | 2 | 3% | 35 | 55% |
| Mother[1] | 2 | 3% | 3 | 5% | 8 | 13% | 23 | 36% | 23 | 36% | 5 | 8% |
| Mother[2] | 4 | 6% | 6 | 9% | 6 | 9% | 22 | 34% | 21 | 33% | 5 | 8% |
| Father[1] | 6 | 9% | 3 | 5% | 17 | 27% | 22 | 34% | 8 | 13% | 8 | 13% |
| Father[2] | 8 | 13% | 6 | 9% | 16 | 25% | 18 | 28% | 8 | 13% | 8 | 13% |
| Siblings[1] | 32 | 50% | 22 | 34% | 6 | 9% | 1 | 2% | 0 | 0% | 3 | 5% |
| Siblings[2] | 33 | 52% | 22 | 34% | 5 | 8% | 1 | 2% | 0 | 0% | 3 | 5% |
| Elders[1] | 1 | 2% | 1 | 2% | 3 | 5% | 14 | 22% | 43 | 67% | 2 | 3% |
| Elders[2] | 1 | 2% | 1 | 2% | 4 | 6% | 13 | 20% | 43 | 67% | 2 | 3% |
| Best Friends[1] | 42 | 66% | 17 | 27% | 3 | 5% | 2 | 3% | 0 | 0% | 0 | 0% |
| Best Friends[2] | 42 | 66% | 17 | 27% | 3 | 5% | 2 | 3% | 0 | 0% | 0 | 0% |
| Other Friends[1] | 47 | 73% | 15 | 23% | 2 | 3% | 0 | 0% | 0 | 0% | 0 | 0% |
| Other Friends[2] | 47 | 73% | 16 | 25% | 1 | 2% | 0 | 0% | 0 | 0% | 0 | 0% |
| Colleagues[1] | 54 | 84% | 10 | 16% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Colleagues[2] | 54 | 84% | 10 | 16% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Neighbours[1] | 46 | 72% | 9 | 14% | 6 | 9% | 1 | 2% | 2 | 3% | 0 | 0% |
| Neighbours[2] | 46 | 72% | 9 | 14% | 6 | 9% | 1 | 2% | 2 | 3% | 0 | 0% |

[1] Receptive
[2] Productive

The language in which participants are addressed by their mothers once they are adults shifts somewhat towards English, perhaps due to mothers' (hypothesised) growing proficiency in English after several decades in the UK; 36% of mothers exclusively use Punjabi with their adult children (Table 11) as compared to 58% when the participant was a child (Table 10). Fathers' patterns shift subtly towards the middle ground between childhood and adulthood; in childhood 25% of participants

reported their fathers would exclusively use Punjabi, 30% mainly Punjabi and 22% an equal mix of Punjabi and English; in adulthood the number of fathers reported to use Punjabi exclusively has roughly halved (from 25% to 13%), with slight increases in the mainly Punjabi category (from 30% to 34%) and the equal mix category (from 22% to 27%) (Table11). Despite this possible subtle shift by fathers, the parental generational still lags behind elders in Punjabi usage levels. Punjabi use with siblings and friends in adulthood remains similar to childhood. New adulthood interlocutor categories indexing use in participants' own families (partners and children), and with their colleagues and their neighbours suggest a continuing (and possibly increasing) dominance of English, but interestingly do indicate a small minority of participants using Punjabi in work environments, in their neighbourhoods and with their children.

Several broad observations arise from survey data. First, data reveal the proximity in which the two languages are used; usage does not follow a pattern in which one language is used exclusively for long periods (as might be the case, for example, for a migrant immersed in a monolingual host culture and not in regular contact with speakers of their other language). Rather, the British English-Punjabi participants mostly employ both languages on a regular basis and mix the two in various ways. Secondly, Punjabi usage appears to be 'squeezed', operating mainly within a restricted set of topic areas (which may coincide with sociolinguistic domains), such as domesticity, and very little in professional discourse. Third, an inter-generational differentiation appears to operate, with maximal use of Punjabi to elder relatives and comparatively less use of Punjabi with friends and siblings, where English dominates. Between childhood and adulthood, English usage with several interlocutors such as mothers, increases slightly.

### 4.3.2. **Principal Component Analysis**

A principal component analysis with varimax rotation was next performed for data reduction on raw interlocutor measures within the survey (Section 3.4).

The reason for focussing on interlocutors (as opposed to other measures in the survey) was the prominence given by interview informants to interlocutors as a potential driver of language choice and the hypothesised possibility that interlocutor could be pertinent information for the language system in deciding likely imminent use of each language. Principal component analysis aims to 'explain as much of the variance of the observed variables as possible using few composite variables' (Lorenzo-Seva, 2013:3). The purpose for undertaking this data reduction was to reduce the raw survey data on interlocutors to a smaller number of aggregated interlocutor variables, informed by the results of the principal component analysis, and test the ability of the resulting variables to predict variance in bilingual differentials.

Data for all interlocutor variables in both childhood and adulthood were included in the principal component analysis. Table 5 indicates all 32 interlocutor measures. As described in Section 3.4, each measure was based on a five point scale containing Only English (0), Mainly English (1), Both equally (2), Mainly Punjabi (3) and Only Punjabi (4).

Table 13, below, reports total variance explained. Seven factors, collectively accounting for just under 80% of the variance across all interlocutor measures, were re-named fairly straightforwardly according to the highest loading observed interlocutor variables within each one, as follows:

Factor 1 - Friends
Factor 2 - Fathers
Factor 3 - Partner & Children
Factor 4 – Elders
Factor 5 - Neighbours & Colleagues
Factor 6 - Mother
Factor 7 - Siblings In Adulthood

Factor loadings are reported in Table 12. In the clustering of observed variables in Factor 3, languages spoken with partners and children, appears to be determined by those participants who have begun a family of their own, possibly establishing new norms of language use, while the clustering within Factor 5, neighbours and colleagues, may be influenced by living or working in more/less densely Punjabi speaking locales or employment settings. (No assumption is made on the direction of influence for either factor.) Other latent variables were clusters of different questions applying to the same interlocutor (e.g. all four measures for friends, etc.) and therefore expected.

### 4.3.3. Aggregated Variables Feeding in to Experimental Analysis

The latent variables identified through principal component analysis were next used to inform the aggregation of new clustered interlocutor variables from survey data. Raw interlocutor survey scores were grouped together in accordance with the latent components. For instance, factor 5 pooled all raw survey scores for language use with neighbours and colleagues. A mean score for the factor was then created. As an example from the Siblings in Adulthood factor, Participant 9 scored 2 for receptive use and 3 for productive use with siblings, hence had an aggregated score of 2.5. In the original five point 0-4 scale, 4 represented exclusive usage of Punjabi with the interlocutor factor and 0 represented no Punjabi use, hence a maximum aggregated score of 4 was possible.

One factor, Factor 3, was excluded from further exploration due to concern that not all participants had partners and/or children; 33% of the participants did not have a spouse and only 55% were parents. All other interlocutor categories applied broadly across participants (e.g. only two participants reported no siblings, two no living mother, two no childhood contact with their father, two no contact with elders and all reported having friends, neighbours, colleagues), though eight reported having no living father by the time they reached adulthood.

The six interlocutor variables feeding in to statistical analysis of experimental data were: Mothers (in adulthood); Fathers; Siblings (in adulthood); Elders; Neighbours and Colleagues; Friends. As described in Section 4.1.4, three other usage variables from the survey were used in conjunction with these: frequency of code-switching, frequency of Punjabi use and the spread of Punjabi use across topics.

**Table 12 Principal Component Analysis – Rotated Component Matrix**

| Survey Variables | Component | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Childhood Language Spoken by Best Friends[1] | .856 | | | | | | |
| Childhood Language Spoken to Other Friends[2] | .850 | | | | | | |
| Childhood Language Spoken by Other Friends[1] | .850 | | | | | | |
| Childhood Language Spoken to Best Friends[2] | .811 | | | | | | |
| Adulthood Language Spoken by Other Friends[1] | .799 | | | | | | |
| Adulthood Language Spoken by Best Friends[1] | .779 | | | | | | |
| Adulthood Language Spoken to Best Friends[2] | .779 | | | | | | |
| Adulthood Language Spoken to Other Friends[2] | .755 | | | | | | |
| Adulthood Language Spoken to Father[2] | | .915 | | | | | |
| Adulthood Language Spoken by Father[1] | | .906 | | | | | |
| Childhood Language Spoken by Father[1] | | .853 | | | | | |
| Childhood Language Spoken to Father[2] | | .849 | | | | | |
| Adulthood Language Spoken to Partner[2] | | | .861 | | | | |
| Adulthood Language Spoken by Partner[2] | | | .851 | | | | |
| Adulthood Language Spoken to Children[2] | | | .846 | | | | |
| Adulthood Language Spoken by Children[1] | | | .838 | | | | |
| Childhood Language Spoken by Elders[1] | | | | .900 | | | |
| Childhood Language Spoken to Elders[2] | | | | .892 | | | |
| Adulthood Language Spoken by Elders[1] | | | | .858 | | | |
| Adulthood Language Spoken to Elders[2] | | | | .852 | | | |
| Adulthood Language Spoken to Neighbours[2] | | | | | .921 | | |
| Adulthood Language Spoken by Neighbours[1] | | | | | .921 | | |
| Adulthood Language Spoken by Colleagues[1] | | | | | .769 | | |
| Adulthood Language Spoken to Colleagues[2] | | | | | .757 | | |
| Childhood Language Spoken to Mother[2] | | | | | | .810 | |
| Childhood Language Spoken by Mother[1] | | | | | | .716 | |
| Adulthood Language Spoken to Mother[2] | | | | | | .689 | |
| Adulthood Language Spoken by Mother[1] | | | | | | .620 | |
| Adulthood Language Spoken by Siblings[1] | | | | | | | .912 |
| Adulthood Language Spoken to Siblings[2] | | | | | | | .909 |

[1] Receptive
[2] Productive

**Table 13 Principal Component Analysis – Total Variance Explained**

| Component | Initial Eigenvalues | % of Variance Explained | Cumulative Variance Explained % |
|---|---|---|---|
| 1 Friends | 7.2 | 22.5 | 22.5 |
| 2 Fathers | 5.9 | 18.4 | 40.9 |
| 3 Partners and Children | 3.6 | 11.2 | 52.1 |
| 4 Elders | 3.2 | 9.9 | 62.1 |
| 5 Neighbours and Colleagues | 2.6 | 8.1 | 70.1 |
| 6 Mother in Childhood | 1.7 | 5.4 | 75.5 |
| 7 Siblings in Adulthood | 1.4 | 4.4 | 79.9 |

The predictor variable on frequency of Punjabi use was formed by creating a mean of two survey measures on speaking and hearing Punjabi respectively; the scale for both questions was five point (Once a month or less/Once a week/2-3 times a week/4-5 times a week/ Daily). The predictor variable on frequency of code switching was formed by using the same five point scale for a single survey question on changing language within a sentence. The predictor variable on spread of Punjabi use across topics was formed by totalling scores for use across the five topic areas (work, domesticity, faith, gossip, news/politics) and dividing by five to create an average.

The nine variables were tested for their ability to predict the differential between experimental conditions using a multiple regression analysis; the results of this are reported in Section 4.4.15. Selection of the predictor variables was theoretically driven. Fine-grained language usage patterns can differ even in well controlled participant groups and, as discussed in Section 2.4, Activation Threshold Hypothesis (Paradis, 2004) posits that changes in the usage pattern of a bilingual's languages may result in changes to the underlying connections that support each language, with increased use of a language potentially leading to a lower activation threshold. According to this we would expect that the usage patterns of participants would impact on language processing, affecting both the level of unconscious activation of the non-target language and the speed with which lexical entries in the non-target language can be retrieved. The decision to explore language usage variables for possible contribution to processing arises from this theoretical basis. The specific operationalization of 'usage' applied here, with a high degree of focus on interlocutors, was informed by qualitative interview data from the participant population itself (presented in Section 4.1), which suggested a potentially important role for interlocutors in driving habitual language choices and possibly also demarcating the boundaries of a

home/family domain. This in turn informed the decision to perform the Principal Component Analysis on interlocutor variables. An alternative analytic approach could have been to explore all (non-aggregated) responses to the survey for correlations with the differential. The approach taken in this study favoured instead the use of exploratory interviews on language use to inform potential areas of interest. The theoretical reason for predictor variables on frequency of use relates to well-known word frequency effects in psycholinguistic research (e.g. Pulvermüller, 2007, Warren, 2013); given that approximately a tenth of participants used Punjabi less than once per month, this predictor variable was also a check against the possibility that variance in frequency of usage accounted for differing experimental performance. The measure used for this predictor variable was participants' self-reported frequency of use of Punjabi, taken from the survey. Given the acknowledged possibility discussed in Section 2.7.4 of Punjabi having developed into a mixed code, the current study intends Punjabi use to cover utterances which are either solely or dominantly Punjabi and which, even if containing considerable English lexis, would be largely unintelligible to non-Punjabi speakers. The inclusion of a switching predictor variable was related to the hypothesised possibility of speakers who frequently switch may hold both languages in greater readiness for use than those who leave one language out of use for long periods. Finally, the predictor variable on topic was included to on the theoretical basis of Fishman's (1971) description of topical regulation as a driver of language choice.

Analysis next proceeded to the experimental data. The next section deals in some detail with the methods of data preparation and with distribution.

## 4.4. Experimental Results

All experimental data were entered into an SPSS master sheet, with one trial per row and a total of 5,120 reaction time data points (128 participants, 40 trials per participant). Following general cleaning and checking, the data were analysed for outliers, errors, knowledge of experimental Punjabi words and distribution. Sections below detail how many data points were removed, where relevant, but it should be noted that some lines of data were removed from analysis for multiple reasons (such as containing both an outlier and an incorrect response).

### 4.4.1. **Outlier Analysis**

Following Chondrogianni and Marinis (2012), extreme values were first identified using SPSS' boxplot procedure and excluded from analysis. 216 of the 5,120 data points across groups were identified in this way. Next, mean and standard deviation by participant and condition were calculated; these were compared with a relevant mean by condition/group and reaction time values more than 2.5SD from the appropriate mean were categorised as outliers and excluded from analysis (111 values).

Individual items (words) were next examined. One entire item, FLOWER/$p^h$ul , was removed from analysis at this stage as the word was subject to regional variation in Punjabi in which its initial consonant might be realised as /f/ rather than /$p^h$/. At the design stage it was envisaged that this variational consideration would affect only a small number of potential participants, however during the Punjabi word test at the end of experiment, a majority of participants produced the word in its f-initial form. As word pairs beginning with the same consonant could not be included in the experiment, this item was removed altogether resulting in the loss of a further 254 values. Table 14 (below) presents mean and standard deviations by group were calculated for each of the remaining items, following this removal and the removal of errors. Reaction time values more than 2.5SD from the appropriate mean were categorised as item outliers and excluded from analysis resulting in nine item removals.

**Table 14 Mean Reaction Time by Item by Group**

| Item | Reaction Time | | | |
|---|---|---|---|---|
| | Bilingual Group | | Monolingual Group | |
| | Mean | *SD* | Mean | *SD* |
| Bird | 1145.36 | 344.69 | 838.83 | 179.97 |
| Bone | 1043.99 | 300.52 | 866.87 | 185.20 |
| Candle | 1158.21 | 354.67 | 874.63 | 185.56 |
| Cat | 1109.22 | 323.62 | 808.02 | 172.93 |
| Curtain | 1171.60 | 346.26 | 893.00 | 204.46 |
| Fish | 1161.12 | 377.68 | 848.66 | 168.81 |
| Fist | 1186.90 | 391.29 | 811.11 | 168.81 |
| Flower | 1407.50 | 366.99 | 801.50 | 78.49 |
| Fly | 1102.70 | 362.87 | 840.72 | 165.53 |
| Foot | 1113.93 | 294.46 | 873.38 | 150.88 |
| Heart | 1142.18 | 349.77 | 865.54 | 205.16 |
| Knife | 1206.00 | 341.31 | 841.12 | 161.36 |
| Monkey | 1220.49 | 339.43 | 946.55 | 188.67 |
| Needle | 1191.11 | 357.76 | 794.21 | 138.93 |
| Pillow | 1137.45 | 381.48 | 842.52 | 191.61 |
| Shirt | 1286.02 | 420.22 | 902.11 | 186.61 |
| Spoon | 1187.39 | 353.42 | 905.52 | 189.51 |
| Watch | 1132.94 | 366.48 | 900.38 | 177.66 |
| Well | 1098.45 | 379.79 | 841.72 | 177.23 |
| Window | 1113.23 | 360.30 | 890.85 | 190.10 |

### 4.4.2. Error Analysis

The data were analysed for errors by participant, by item, by phoneme and by phonological information (voice, place and manner of articulation; contrastive aspiration in Punjabi) with the intention of removing items with high error rates across both groups. Error rates for some categories (such as contrastive aspiration, where there could be particular reason to expect Punjabi speakers could respond differently to certain categories of phoneme) were broken down by group and items with higher error rates affecting only the bilingual group were retained for further inspection. High error rates across groups were seen as indicative of a problematic item, while higher error rates for bilinguals could indicate interference.

### 4.4.3. Error by Participant and Group

Three monolingual participants were removed due to high error rates (above 20% of trials answered incorrectly). After the removal of these three participants, the total number of data points was reduced from 5,120 to 5,000, of which 5.1% (n=257) were answered incorrectly. Error rates

between groups did not show a statistically significant difference (Wilcoxon, $z$=-.425, $p$=.671). Error percentages did not significantly differ between conditions within either the bilingual group (Wilcoxon, $z$=-1.034, $p$=.301) or the monolingual group (Wilcoxon, $z$=-1.758, $p$=.079).

#### 4.4.4. Error by Item

Frequencies were calculated for error by item, listed in Table 15. Error rates for the item BONE/hadee and CURTAIN/purdah were investigated further due to their high rate. For BONE/hadee, 35 of the 46 errors were made by the bilingual group in the Unrelated condition while for CURTAIN/purdah, 22 of the 33 errors were made by the bilingual group in the Related Condition. As these high error rates originated mainly from the bilingual group and not from an even spread across both groups, the affected items were not removed from analysis; high error rates mainly affecting the bilingual group were not necessarily considered a sign of a problematic item, as they could potentially be symptomatic of interference.

#### 4.4.5. Error by Voicing

Error rates were similar across voiced and voiceless consonants across groups: 4.6% of trials involving a voiced consonant were answered incorrectly compared with 6.1% for voiceless consonants; the bilingual group error rate was 2.4% (n=75) for voiced trials and 3.2% (n=60) for voiceless trials, while the monolingual group error rate was 2.2% (n=68) for voiced trials and 2.9% (n=54) for voiceless trials.

#### 4.4.6. Error by Place of Articulation

Error rates (reported in Table 16) were similar across place of articulation of the experimental consonants with no consonant having an error rate higher than 7%. Error differences between the bilingual and monolingual group were less than 3% across all places of articulation.

**Table 15 Overall Error by Item**

| **Item** | **Errors** | |
|---|---|---|
| | n. | %* |
| Bird | 7 | 2.8% |
| Bone | 46 | 18.4% |
| Candle | 3 | 1.2% |
| Cat | 10 | 4.0% |
| Curtain | 31 | 12.4% |
| Fish | 12 | 4.8% |
| Fist | 12 | 4.8% |
| Flower | 18 | 7.2% |
| Fly | 4 | 1.6% |
| Foot | 14 | 5.6% |
| Heart | 5 | 2.0% |
| Knife | 7 | 2.8% |
| Monkey | 15 | 6.0% |
| Needle | 8 | 3.2% |
| Pillow | 12 | 4.8% |
| Shirt | 14 | 5.6% |
| Spoon | 5 | 2.0% |
| Watch | 16 | 6.4% |
| Well | 8 | 3.2% |
| Window | 10 | 4.0% |
| **Total** | **257** | **5.1%** |

* Percentage of 5,000 trials

**Table 16 Overall Error by Place of Articulation of Experimental Phoneme**

| **Place of Articulation** | **Error** | |
|---|---|---|
| | n | % |
| Alveolar | 99 | 2.0% |
| Bilabial | 86 | 1.7% |
| Glottal | 3 | 0.1% |
| Labial-velar | 11 | 0.2% |
| Labio-dental | 31 | 0.6% |
| Post-alveolar | 24 | 0.5% |
| Velar | 24 | 0.5% |
| **Total** | **278** | **5.6%** |

* Percentage of 5,000 trials

### 4.4.7. Error by Manner of Articulation

Error rates for approximant, nasal, fricative, affricate and plosive consonants (Table 17) were all below 7% with error rate differences across groups all below 2%. Error for the lateral approximant /l/ was higher, at 20.8% (n=53). Exploration of this error rate by group revealed that the Punjabi group accounted for 37 of the 53 errors and so this item was retained.

**Table 17 Error by Manner of Articulation**

| Manner of Articulation | Total Trials | Bilingual Group Error | | Monolingual Group Error | | Total Error | |
|---|---|---|---|---|---|---|---|
| | | n. | %* | n. | %* | n. | %* |
| Affricate | 374 | 10 | 2.7% | 6 | 1.6% | 16 | 4.3% |
| Approximant (r) | 502 | 5 | 0.0% | 6 | 1.2% | 11 | 2.2% |
| Fricative | 1251 | 20 | 1.6% | 26 | 2.1% | 46 | 3.7% |
| Lateral Approximant (l) | 249 | 37 | 14.9% | 16 | 6.4% | 53 | 21.3% |
| Nasal | 749 | 8 | 1.1% | 14 | 1.9% | 22 | 2.9% |
| Plosive | 1875 | 55 | 2.9% | 54 | 2.9% | 109 | 5.8% |

* Percentage of total trials containing this category of phoneme, e.g. 4.3% of all 374 trials containing affricates were answered incorrectly (bilingual errors 2.7% / monolingual errors 1.6%).

### 4.4.8. Error by Contrastive Aspiration

Error rates by contrastive aspiration status are reported in Table 18. Consonants affected by contrastive aspiration in Punjabi attracted similar error rates to those not affected by contrastive aspiration in Punjabi across both the bilingual and monolingual groups and no items were removed.

**Table 18 Error by Contrastive Aspiration**

| Error by Contrastive Aspiration | Total Trials | Total Errors | Bilingual Group Errors | | Monolingual Group Errors | |
|---|---|---|---|---|---|---|
| | n. | n. | n. | %* | n. | %* |
| Contrastive aspiration applies in Punjabi | 2248 | 126 | 65 | 0.03 | 61 | 2.7 |
| Contrastive aspiration absent in Punjabi | 2752 | 131 | 70 | 0.03 | 61 | 2.2 |

* Percentage of total trials containing this category of phoneme, e.g. 126 of all 2248 trials containing contrastive aspiration phonemes were answered incorrectly; bilingual errors 0.03%/monolingual errors 2.7%.

### 4.4.9. Mean RT and Error for Individual Phonemes

Based on earlier discussion of the possibility for British Asian accent features in the stimuli to be detectable to participants, error rate and mean RT for each individual phoneme are reported in Table 19 for the bilingual participants only. Several phonemes are affected by higher error rates, /l/ (12.4%) and /ʧ/ (9.5%) in particular. The fastest RTs are for the phonemes /h, t, k, l/. The possibility that this may indicate that detectable Punjabi accent features in these phonemes means they can be more easily dismissed by bilingual participants is discussion in Section 5.1).

**Table 19 Mean RT and Error for Individual Phonemes**

| Phoneme | Mean RT | Total Error | Percentage Error* |
|---|---|---|---|
| b | 1142.3 | 5 | 4 |
| ch | 1177.36 | 8 | 9.5 |
| d | 1153.88 | 1 | 0.9 |
| f | 1239.33 | 1 | 1.9 |
| g | 1121.86 | 3 | 2.6 |
| h | 1008.83 | 0 | 0 |
| k | 1064.12 | 2 | 2.5 |
| l | 1084.48 | 29 | 12.4 |
| m | 1132.2 | 5 | 4.8 |
| n | 1202.49 | 1 | 1.4 |
| p | 1131.35 | 22 | 10 |
| s | 1189.91 | 3 | 1.6 |
| sh | 1196.51 | 0 | 0 |
| t | 1042.1 | 1 | 0.4 |
| v | 1115.89 | 7 | 4.6 |
| w | 1148.22 | 2 | 2.9 |

*The total number of appearances was not the same for all phonemes, so percentage error is more important than total error

### 4.4.10. **Knowledge of Punjabi Words**

Post-experimental procedures checked whether the Punjabi versions of experimental words formed part of the bilingual participants' Punjabi lexicons (reported in Table 20) the focus of the experiment being on whether the contents of the Punjabi lexicon were active (i.e. not to judge the extent of a speaker's Punjabi lexicon, but to seek evidence for the activation of those words which do form part of the speaker's Punjabi lexicon). Where participants knew alternative Punjabi words for the items due to variational differences and not the Punjabi word employed in the experiment, they were recorded as not knowing the word.

**Table 20 Knowledge of Punjabi words among English-Punjabi Bilinguals**

| Item | Total Trials (Bilinguals Only) | Trials in which Punjabi word was <u>not known</u> to English-Punjabi bilingual | | Trials in which Punjabi word was <u>known</u> to Punjabi English-Punjabi bilingual | |
|---|---|---|---|---|---|
| | n. | n. | %* | n | %* |
| Bird | 128 | 0 | 0.0% | 128 | 100% |
| Bone | 128 | 8 | 6.3% | 120 | 94% |
| Candle | 128 | 16 | 12.5% | 112 | 87% |
| Cat | 128 | 0 | 0.0% | 128 | 100% |
| Curtain | 128 | 40 | 31.3% | 88 | 69% |
| Fish | 128 | 4 | 3.1% | 124 | 97% |
| Fist | 128 | 25 | 19.5% | 103 | 80% |
| Flower | 128 | 0 | 0.0% | 128 | 100% |
| Fly | 128 | 3 | 2.3% | 125 | 98% |
| Foot | 128 | 0 | 0.0% | 128 | 100% |
| Heart | 128 | 0 | 0.0% | 128 | 100% |
| Knife | 128 | 15 | 11.7% | 113 | 88% |
| Monkey | 128 | 4 | 3.1% | 124 | 97% |
| Needle | 128 | 2 | 1.6% | 126 | 98% |
| Pillow | 128 | 10 | 7.8% | 118 | 92% |
| Shirt | 128 | 28 | 21.9% | 100 | 78% |
| Spoon | 128 | 4 | 3.1% | 124 | 97% |
| Watch | 128 | 3 | 2.3% | 125 | 98% |
| Well | 128 | 26 | 20.3% | 102 | 80% |
| Window | 128 | 74 | 57.8% | 54 | 42% |
| | 2560 | 262 | | 2298 | |

*Percentage of all 128 trials

In 89.8% (n=2298)[19] of all bilingual responses, the participant knew both the Punjabi and English glosses for the experimental item. Breakdowns of the percentage of participants who did not know each individual item are given in Table 20. The least known Punjabi words were: CURTAIN/purdah, WELL/khooh, SHIRT/kameez and WINDOW/baaree. Most participants reporting *kameez* and *purdah* as unknown did so because their families code-switched the English versions into their Punjabi usage (cf. Stuart-Smith, 1999, on the incorporation of English lexis into British Punjabi). WINDOW/baaree was subject to a variational difference in that a number of participants used an

[19] Total bilingual responses were 2560 (half of the original 5120 trials).

alternative form of the word (one candidate who knew both Punjabi words for window was recorded as not knowing the word as it would be unclear which version was most active).

### 4.4.11. Distribution

As is usual for reaction time distributions (Marinis, 2010; Ratcliff, 1993), the data were not normally distributed (Kolmogorov-Smirnov, $p$=.000, see Figure 6). Means by group and condition are displayed in Table 21.

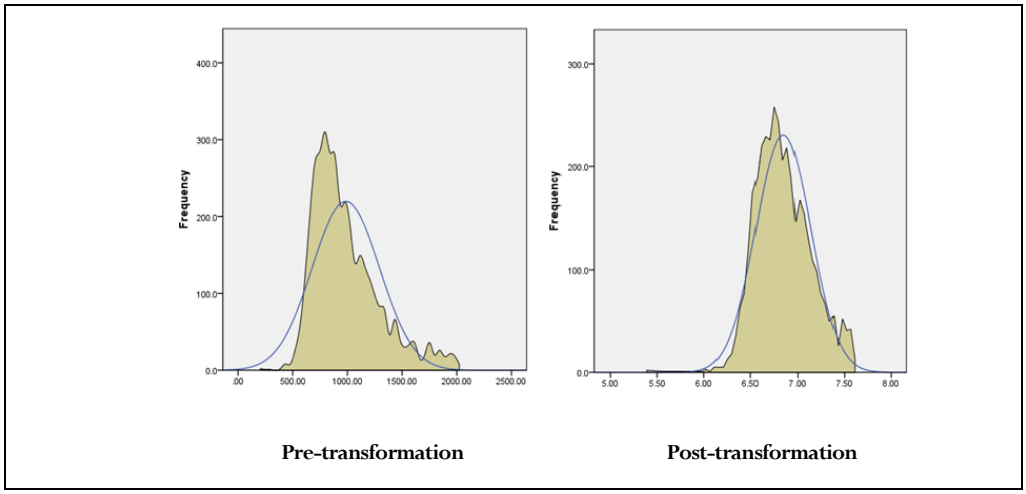
**Table 21 Mean reaction time by group and condition following and error outlier removal**

| **Bilingual Group** | | | | **Monolingual Group** | | | |
|---|---|---|---|---|---|---|---|
| **Related Condition** | | **Unrelated Condition** | | **Related Condition** | | **Unrelated Condition** | |
| Mean | *SD* | Mean | *SD* | Mean | *SD* | Mean | *SD* |
| 1145.25 | 360.76 | 1134.81 | 358.50 | 868.78 | 168.68 | 853.86 | 194.36 |

A natural log transformation was applied to bring the data closer to normal distribution, following Linck, Schwieter & Sunderman (2012). Post-transformation explorations of data were explored by condition and group (not as an overall group) to ensure that transformations achieved a closer to normal distribution shape at each of these levels (as presented in Figure 6). In the analysis that follows, while transformed data was analysed, values are reported in their whole form for ease of interpretation. From this point, unless otherwise stated, analysis proceeded using filters to exclude: a) incorrectly answered trials; (b) trials in which the Punjabi name for the experimental item was not known to bilingual subjects; and (c) with exclusions for boxplot, item and 2.5SD outliers. The total number of data points remaining was 3,765.

**Figure 6 Distributions of reaction time data before and after log transformation.**

The left hand image displays untransformed reaction time data following outlier removal (boxplot outliers, 2.5 SD outliers, item outliers, error, knowledge of Punjabi picture). The right hand image displays the same data following a natural log transformation.




### 4.4.12. Experimental Group Differences

Overall reaction times for the bilingual group were slower than those of the monolingual participants (see Table 14, above). Subject analysis examined differences between group (bilingual/monolingual) and condition (Related/Unrelated); a mixed-model ANOVA was performed with group as a between-subjects factor and condition as a within-subjects factor. Condition was not significant $F(1,123)=.187$, $p=.666$ and there was no significant group by condition interaction, $F(1,123)=.001$, $p=.974$. The group difference was significant, $F(1,123)=48.48$, $p=<.001$, confirming significantly slower reaction times for the bilingual participants. These results indicate that, at a group level at least, English-Punjabi bilinguals did not take longer to reject phonemes which were present in the Related condition, but did have overall slower reaction times. In analysis by item (mixed-model Anova with condition as a within factor and group as a between), there was also no significant difference between conditions $F(1,36)=.530$, $p=.472$ and no group by condition interaction $F(1,36)=.02$, $p=.887$. The difference between groups was again significant $F(1,36)=269$, $p=<.001$.

### 4.4.13. Bilingual Within-Group Variation

As planned, analysis next explored variation within the bilingual group, focussing on reaction time differentials between the two conditions; as set out in Section 4.2 above, the differential value for each participant was calculated by subtracting the mean reaction time for the Related condition from the

mean reaction time for the Unrelated condition (Unrelated – Related = Differential).Thus a negative value for the differential indicates a slower mean reaction time in the Related condition, consistent with interference from the non-target language.

Descriptives for the differentials are reported in Appendix 5. The standard deviations reported in Table 21 indicate that variance within the bilingual group reaction times was greater than within the monolingual reaction times. The mean bilingual differential was -.02 ms(*SD* 0.97) and the monolingual was -.02 ms (*SD* 0.05) A language processing scenario in which Punjabi is receiving no activation at all should, it might be argued, resemble monolingual processing, as argued by Kroll and colleagues (2012), among others.

For 57 of the 61 monolingual participants' (93%), the differential between conditions represented no more than 10% of the Unrelated condition mean reaction time baseline. Figure 8 shows participants divided into three groups based on response times in the two conditions:

a) Related Condition Slower – indicating a participant's mean response time for the Related condition was at least 10% *slower* than the mean response time for the Unrelated Condition.
b) Less than 10% Difference – indicating that the difference between two conditions was less than 10%.
c) Related Condition Faster – indicating a participant's mean response time for the Related condition was at least 10% *faster* than the mean response time for the Unrelated Condition.

Most monolinguals (n=57) were in the middle group, with less than 10% difference between the two reaction times.

Following the argument that language processing in which lexical representations from the non-target language are not being accessed should resemble monolingual processing patterns, if bilingual participants were not accessing Punjabi lexical representations when completing the task, similar response times for both conditions should be expected. In the bilingual group, however, only 57.8% (n=37) of the differentials indicated a difference of less than 10% between the two conditions (see Figure 8, below). For 26.6% (n=17) of bilinguals the differentials were more than 10% *slower* than the Unrelated baseline, while for 15.6% (n=10) the differentials were more than 10% *faster*.

**Figure 7 Boxplot: Monolingual/Bilingual Reaction Time and Differential**

Boxplots of absolute reaction time in each group (left) and the differential between conditions (right). A positive differential value indicates a faster response in the condition with a Punjabi distracter phoneme while a negative value indicates a slower response in the condition with a Punjabi distracter phoneme.

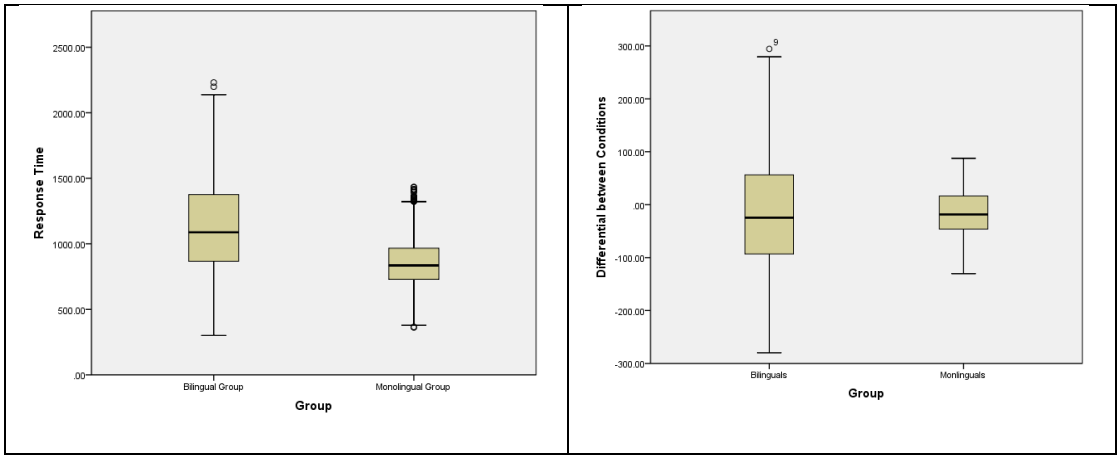
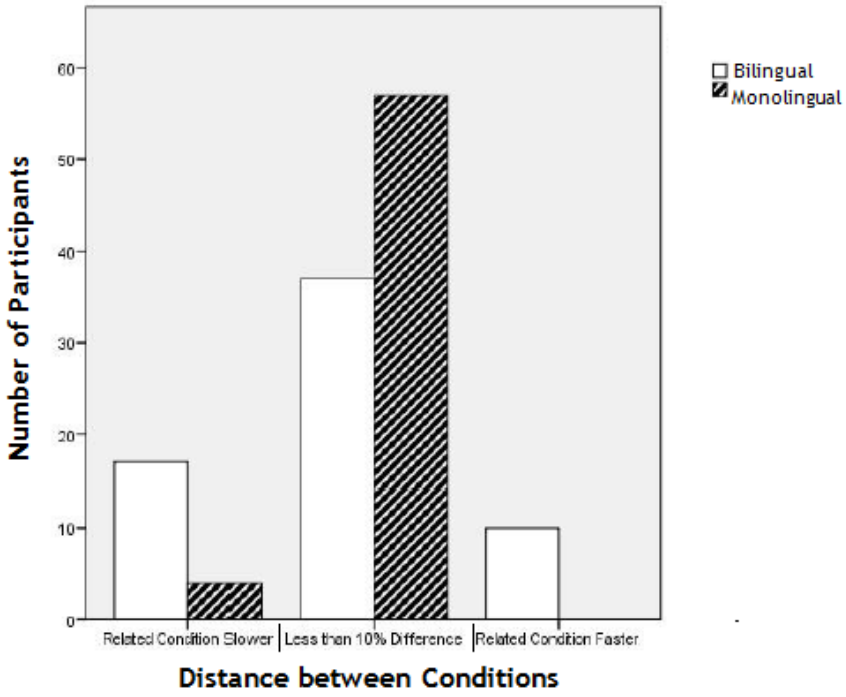



**Figure 8 Monolingual/Bilingual Range of Difference between Conditions (%)**

Most monolingual values indicated less than 10% difference between conditions (see central patterned bar) while bilingual values were more varied (as indicated by white bars).




At this point, analysis presented the possibility of a range of processing responses to the experiment among bilingual participants. The next step in analysis was to seek a relationship between the levels of differential between conditions and other factors, using the predictor variables developed (detailed in Section 4.3.3).

As stressed in Section 3.1, there was a high degree of demographic homogeneity among the bilingual participants (as monoliterate, second generation, British Asian, English-Punjabi, early bilinguals, resident in the UK and educated only in English, etc.). On this basis the possibility of confound was not felt to be the cause of variance in bilingual responses. If, as some researchers argue, language is a 'living system' and each bilingual speaker therefore unique as a result of their response to varied input[20] the variation would more likely result from finer-grained differences in usage. This possibility was next explored, with analysis assessing the ability for various language use factors (described in Section 4.3.3) to predict a speaker's level of reaction time differential between conditions.

### 4.4.14. Correlations between Experimental Data and Language Use

Correlation analysis explored potential linkages between experimental performance by bilinguals and a range of language usage measures arising from survey data. Language use factors used in the correlations included:

- individual topic measures, plus measures which created a score for use of Punjabi across the topic measures (described in Section 3.4)
- individual interlocutor measures, plus measures which created a total use score across several interlocutors, such as all interlocutors in adulthood or in childhood

An 'adult interlocutors combined' score was based on adult use of Punjabi with eight interlocutors: mothers, fathers, siblings, partners, children, friends, neighbours, colleagues. There were two survey measures for each interlocutor, one for receptive use and one for productive use, and scores ranged from 0 to 4, with 0 representing only English and 4 representing only Punjabi. Hence each individual interlocutor had a maximum possible score of 8 (use of Punjabi only). The maximum possible score for any individual across all interlocutors would be 64, representing sole use of Punjabi with all eight interlocutors. Similarly, a 'childhood interlocutors combined' score was based on childhood use of Punjabi with four interlocutors: mothers, fathers, siblings and friends. The maximum possible score for each individual participant was 32, representing sole use of Punjabi with all four interlocutors. A measure for frequency of Punjabi use was composed of a mean of the two survey measures (frequency of hearing Punjabi and speaking Punjabi) and had a maximum score of 4. A measure for the frequency

[20] Guillaume Thierry, personal communication, 29 January 2014.

of switching was based on a single survey measure, also having had a maximum score of 4. Finally, participants' age was also tested for correlation with the differential.

Experimental factors included (a) the differential between conditions (described in Section 4.2), (b) participant mean RT for the Related Condition, (c) participant mean RT for the Unrelated Condition and (d)overall mean RT per participant.

Several usage factors which could be expected to be influential, such as mothers and elders, showed no effect, while moderate correlations were found in a small number of other areas, reported below.

***Results of Correlation Analysis***

*Age.* Analysis found no significant correlations between participant age and any of the four experimental RT factors.

*Spread of Punjabi across Topics.* Table 22 reports correlation between experimental performance and the use of Punjabi in different topics (talking about work, domestic/family talk, prayer, gossip, news, and all topics combined score). The topics of work and gossip showed no significant correlation with experimental performance. The topics of family talk and news both correlated with overall RT and the RT in each condition, but not with the differential between conditions. Prayer showed a correlation with overall RT and the Unrelated condition. There was, however, a correlation between all RT measures and participants' combined score for use of Punjabi across all topics.

*Interlocutors.* Table 23 reports correlations between experimental performance and interlocutors. The interlocutor categories of elders, mothers and combined childhood interlocutors showed no correlations with any measure of experimental performance. The interlocutor categories of siblings and spouse/children correlated with overall RT and both condition RTs, but not the differential RT. Correlations with the differential were found for fathers and for a combined score for use of Punjabi with all interlocutors during adulthood. Correlations with the differential were found in the interlocutor categories of fathers, neighbours/colleagues and combined adult interlocutors.

*Frequency.* As reported in Table 24, frequency of Punjabi use and frequency of switching both correlated with overall RT, including RT in each condition, but not with the differential.

**Table 22 Correlations between Use of Punjabi in Different Topics and Experimental RT Factors**

| Correlation Pair | Correlation Coefficient (Spearman) | Significance |
|---|---|---|
| Talking about work / RELATED RT | - | ns |
| Talking about work / UNRELATED RT | - | ns |
| Talking about work / OVERALL MEAN RT | - | ns |
| Talking about work / RT DIFFERENTIAL | - | ns |
| Domestic & family talk / RELATED RT | .303 | .016 |
| Domestic & family talk / UNRELATED RT | .345 | .006 |
| Domestic & family talk / OVERALL MEAN RT | .333 | .008 |
| Domestic & family talk / RT DIFFERENTIAL | - | ns |
| Prayer / RELATED RT | - | ns |
| Prayer / UNRELATED RT | .269 | .049 |
| Prayer / OVERALL MEAN RT | .283 | .038 |
| Prayer / RT DIFFERENTIAL | - | ns |
| Gossip / RELATED RT | - | ns |
| Gossip / UNRELATED RT | - | ns |
| Gossip / OVERALL MEAN RT | - | ns |
| Gossip / RT DIFFERENTIAL | - | ns |
| News & politics / RELATED RT | .369 | .001 |
| News & politics / UNRELATED RT | .454 | .001 |
| News & politics / OVERALL MEAN RT | .495 | .001 |
| News & politics / RT DIFFERENTIAL | - | ns |
| All topics total score / RELATED RT | .238 | .059 |
| All topics total score / UNRELATED RT | .350 | .005 |
| All topics total score / RELATED RT | .344 | .005 |
| All topics total score / RT DIFFERENTIAL | .254 | .043 |

**Table 23 Correlations with individual interlocutors**

| Correlation Pair | Correlation Coefficient (Spearman) | Significance |
|---|---|---|
| Factor 1, Friends / RELATED RT | - | ns |
| Factor 1, Friends / UNRELATED RT | .294 | .019 |
| Factor 1, Friends / OVERALL MEAN RT | - | ns |
| Factor 1, Friends / RT DIFFERENTIAL | - | ns |
| Factor 2, Fathers / RELATED RT | - | ns |
| Factor 2, Fathers / UNRELATED RT | - | ns |
| Factor 2, Fathers / OVERALL MEAN RT | - | ns |
| Factor 2, Fathers / RT DIFFERENTIAL | .304 | 0.015 |
| Factor 3, Spouse & children / RELATED RT | .365 | .003 |
| Factor 3, Spouse & children / UNRELATED RT | .416 | .001 |
| Factor 3, Spouse & children / OVERALL MEAN RT | .385 | .002 |
| Factor 3, Spouse & children / RT DIFFERENTIAL | - | ns |
| Factor 4, Elders / RELATED RT | - | ns |
| Factor 4, Elders / UNRELATED RT | - | ns |
| Factor 4, Elders / OVERALL MEAN RT | - | ns |
| Factor 4, Elders / RT DIFFERENTIAL | - | ns |
| Factor 5, Neighbours & Colleagues / RELATED RT | - | ns |
| Factor 5, Neighbours & Colleagues / UNRELATED RT | .420 | .001 |
| Factor 5, Neighbours & Colleagues / OVERALL MEAN RT | .332 | .007 |
| Factor 5, Neighbours & Colleagues / RT DIFFERENTIAL | .476 | .001 |
| Factor 6, Mother / RELATED RT | - | ns |
| Factor 6, Mother / UNRELATED RT | - | ns |
| Factor 6, Mother / OVERALL MEAN RT | - | ns |
| Factor 6, Mother / RT DIFFERENTIAL | - | ns |
| Factor 7, Siblings / RELATED RT | .302 | .015 |
| Factor 7, Siblings / UNRELATED RT | .371 | .003 |
| Factor 7, Siblings / OVERALL MEAN RT | .362 | .003 |
| Factor 7, Siblings / RT DIFFERENTIAL | - | ns |
| Adult interlocutors combined / RELATED RT | .301 | .016 |
| Adult interlocutors combined / UNRELATED RT | .436 | .001 |
| Adult interlocutors combined / OVERALL MEAN RT | .389 | .001 |
| Adult interlocutors combined / RT DIFFERENTIAL | .327 | .004 |
| Childhood interlocutors combined / RELATED RT | - | ns |
| Childhood interlocutors combined / UNRELATED RT | - | ns |
| Childhood interlocutors combined / OVERALL MEAN RT | - | ns |
| Childhood interlocutors combined / RT DIFFERENTIAL | .222 | (.077)ns |

**Table 24 Correlation with frequency of Punjabi use and switching**

| Correlation Pair | Correlation Coefficient (Spearman) | Significance |
|---|---|---|
| Frequency of switching / RELATED RT | .366 | .003 |
| Frequency of switching / UNRELATED RT | .421 | .001 |
| Frequency of switching / OVERALL MEAN RT | .431 | .001 |
| Frequency of switching / RT DIFFERENTIAL | - | ns |
| Frequency of Punjabi use / RELATED RT | .445 | .001 |
| Frequency of Punjabi use / UNRELATED RT | .482 | .001 |
| Frequency of Punjabi use / OVERALL MEAN RT | .484 | .001 |
| Frequency of Punjabi use / RT DIFFERENTIAL | - | ns |

### *Scatterplots: Correlations with the RT Differential*

Scatterplots were next produced to examine the direction of the moderate correlations reported above. Plots were produced for the following usage measures involving a correlation with the differential: language use across all topics; language use with fathers; language use with neighbours and colleagues; combined language across all interlocutors during adulthood; combined language across all interlocutors during childhood, which was included although just below significance. (The scatterplot for neighbours and colleagues can be found in Section 4.4.15 as it is reported alongside the multiple regression analysis.) Y axes in the scatterplots below indicate the language use rating; measures are designed so that higher scores indicate a greater use of Punjabi. The X axes indicate differential scores; positive differential values indicate that Related RT was faster than the Unrelated. The scatterplots presented below are consistent with the possibility that, as use of Punjabi increases, the ability to dismiss the Punjabi distracter rapidly may be subject to slight increase.

**Figure 9 Correlations between differential and use of Punjabi across topics (with jitter)**

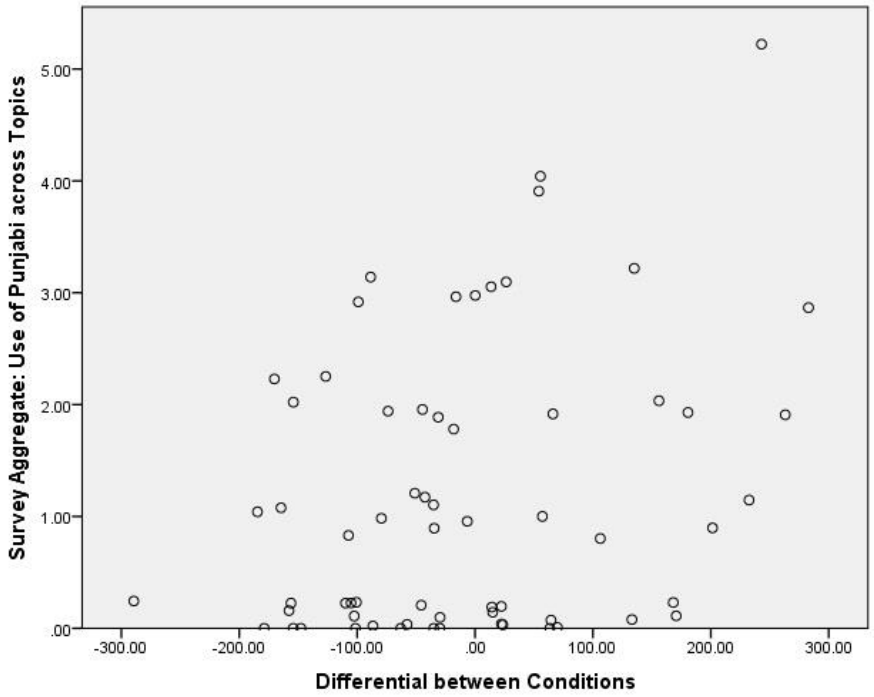



**Figure 10 Correlation between Differential and Use of Punjabi with Fathers**

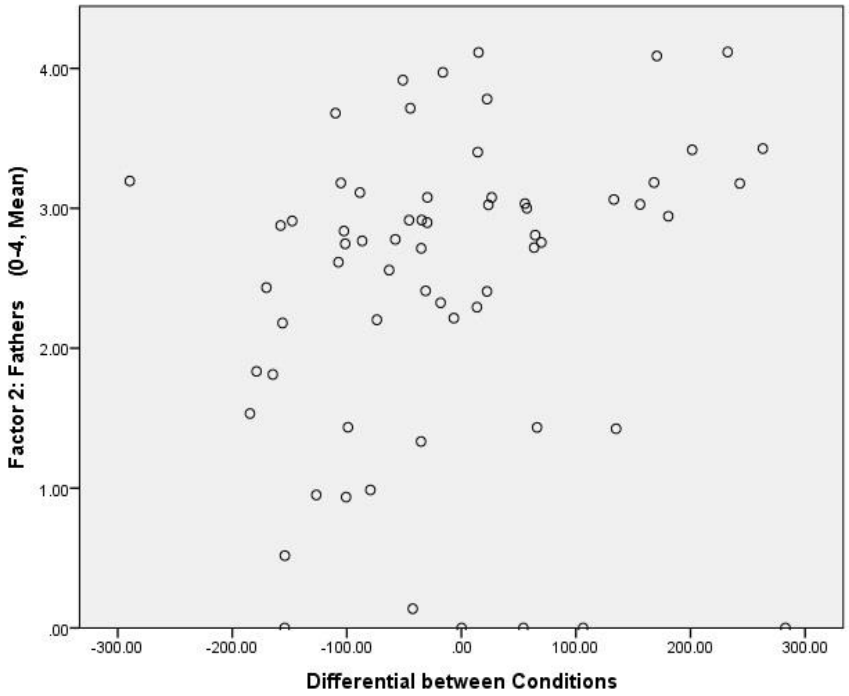


**Figure 11 Correlation between Differential and Use of Punjabi with all interlocutors combined (adulthood)**

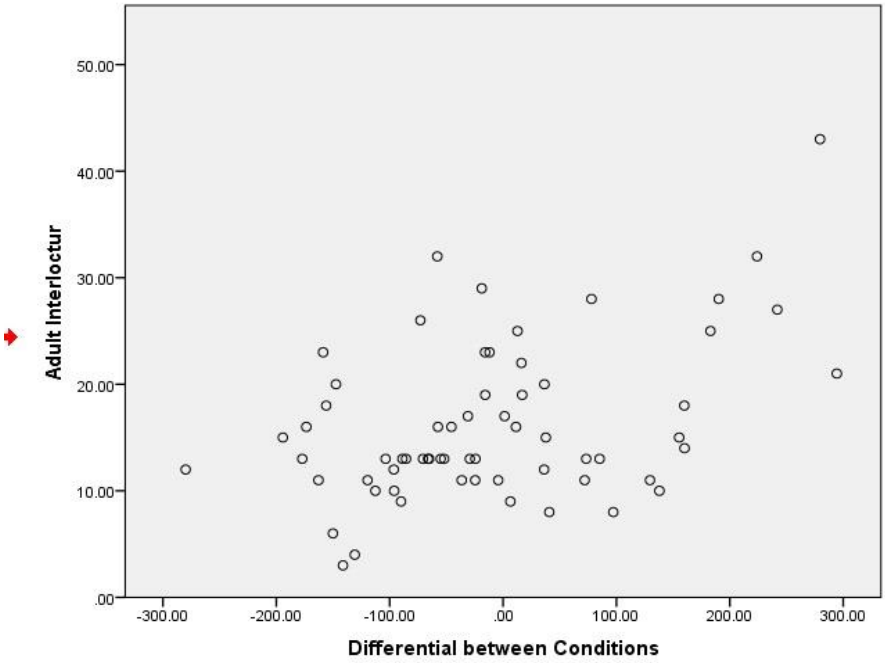
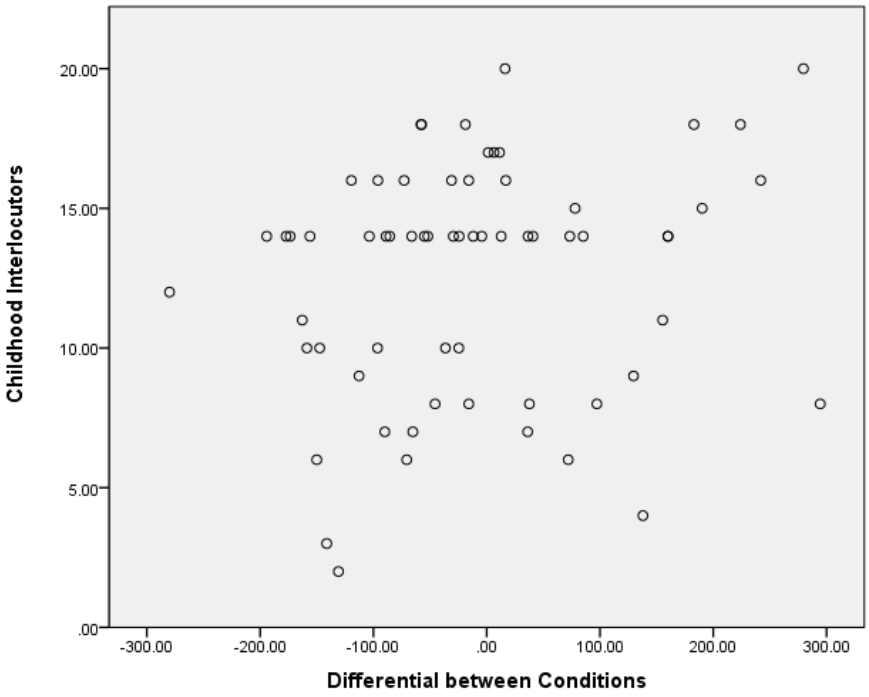



**Figure 12 Correlation between Differential and Use of Punjabi with all interlocutors combined (childhood)**



### 4.4.15. **Multiple Regression Analysis: Language Use and Experimental Variance:**

The purpose of this analysis was to explore the possibility of a partial contribution from the selected language usage factors to some of the variance observed in the differentials between experimental conditions; the analysis was exploratory in that there was no *a priori* hypothesis about which of the nine variables (six interlocutor variables, code-switching frequency, age and frequency of Punjabi use), if any, would have predictive value. The single dependent variable was the differential between Related and Unrelated conditions; specifically this measure consisted of the reaction time difference between conditions. Negative differential values indicated slower responses in the Related Condition and were thus consistent with interference from Punjabi.

A multiple regression was performed on the nine predictor variables, with differential as dependant variable. The least significant variable was then removed from the model, one at a time, until all predictor variables were significant at the $p$=<0.2 level (in the final model, the only predictor variables significant at the $p$=<0.2 level were both also below $p$=0.05). Four of the six interlocutor variables explored did not contribute significantly (friends, fathers, elders and mother), neither did the remaining three variables (frequency of Punjabi use, topic and code-switching frequency) contribute significantly. In the final model containing two interlocutor variables, Neighbours/Colleagues and Siblings in Adulthood significantly contributed to the variance in the differential, $F(2,61)=13.816$, $p$=<.001, $R$=.558, $R^2$=.312, suggesting that these variables in combination were associated with just under a third of the variance, the remaining variance being unaccounted for. Table 25 reports beta weights, significance values, Variance Inflation Factor (VIF) and Tolerance values for the two predictor variables in the final model. Correlations between the two predictor variables were not significant ($r$=.084, $p$=.255), which, together with VIF and tolerance values, suggests that levels of multicollinearity were inconsequential.

**Table 25 Multiple Regression**

| Predictor Variables | B | Standard Error | Standardised Coefficient (Beta) | t | Sig | Tolerance | VIF |
|---|---|---|---|---|---|---|---|
| Neighbours and Colleagues | 117.255 | 25.467 | .491 | 4.604 | .000 | .993 | 1.007 |
| Siblings in Adulthood | 37.241 | 17.386 | .228 | 2.142 | .036 | .993 | 1.007 |

Graphical representations of the data were used to inspect the direction of the relationship between the interlocutor variables (Neighbours and Colleagues/Siblings in Adulthood) and the differential, presented in Figures 6 and 7 below. Jitter was added to both scatterplots to aid visual interpretability; jitter adds small levels of random variation so that dots generated from interval data do not sit on top of one another in a scatter plot. Y axes in the charts indicate the aggregated interlocutor score (0 = no Punjabi use, 4 = exclusive Punjabi use), thus a rise on the Y axis indicates small incremental increases in Punjabi use with the interlocutor. X axes indicate differentials, which may have either positive or negative values. As set out in Section 4.2, a negative value indicates that the Related condition was slower than the Unrelated (consistent with interference).

In Figure 13, most data points on the Y axis (use of Punjabi with neighbours and colleagues) are at zero, reflecting generally low use of Punjabi with neighbours and colleagues (a zero score indicates no use of Punjabi with these interlocutors). Of the few participants who have scores at 1 or above on the Y axis, more have a positive differential values on the X axis, indicating less interference. This patterning can cautiously be seen as consistent with marginally increased use of Punjabi with Neighbours and Colleagues associating with less interference from Punjabi during the experiment. In Figure 14, increased use of Punjabi with siblings is somewhat more evenly spread across the differential spectrum than is the case for neighbours and colleagues, however Y axis values above 2.0 tend to be positive values, again suggesting that slight increases in Punjabi use with siblings could associate with slightly less interference from Punjabi during the experimental task. It is noteworthy that use of both Punjabi and English are common and expected within the home/family domain; use of Punjabi with siblings does not therefore contravene expectations based on sociolinguistic domains of use, as would be the case with neighbours and colleagues. This observation is returned to in Chapter 5 where these results are discussed.

**Figure 13 Scatterplot: Neighbours & Colleagues and Differential**

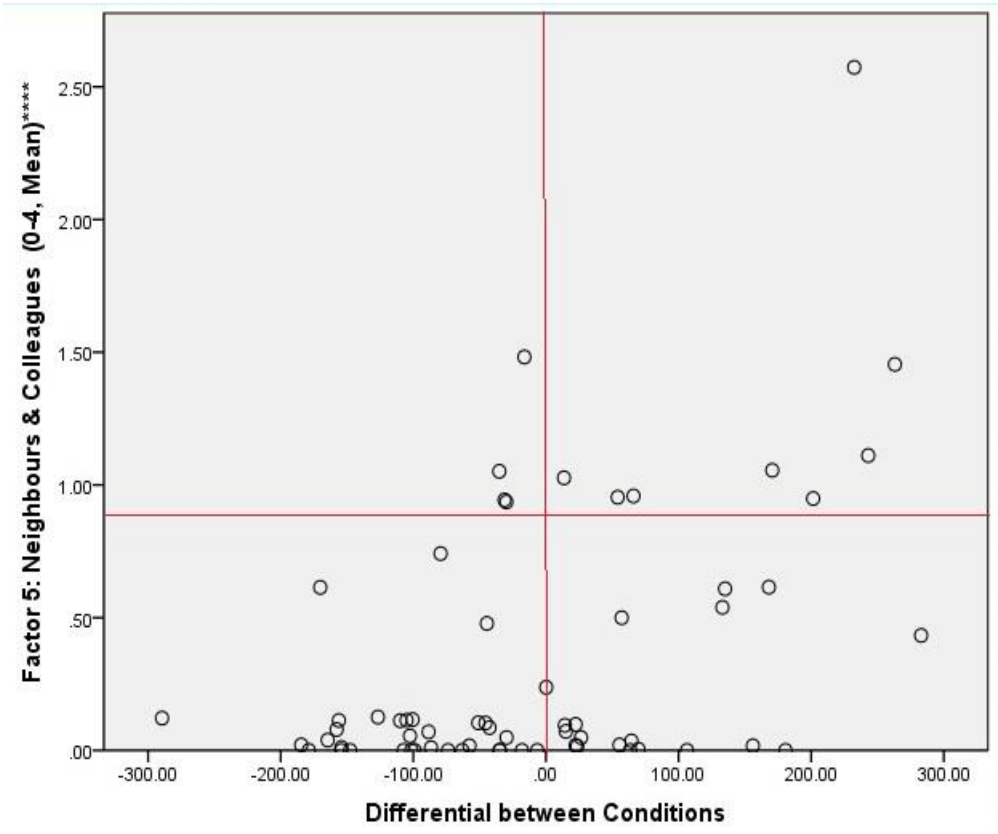
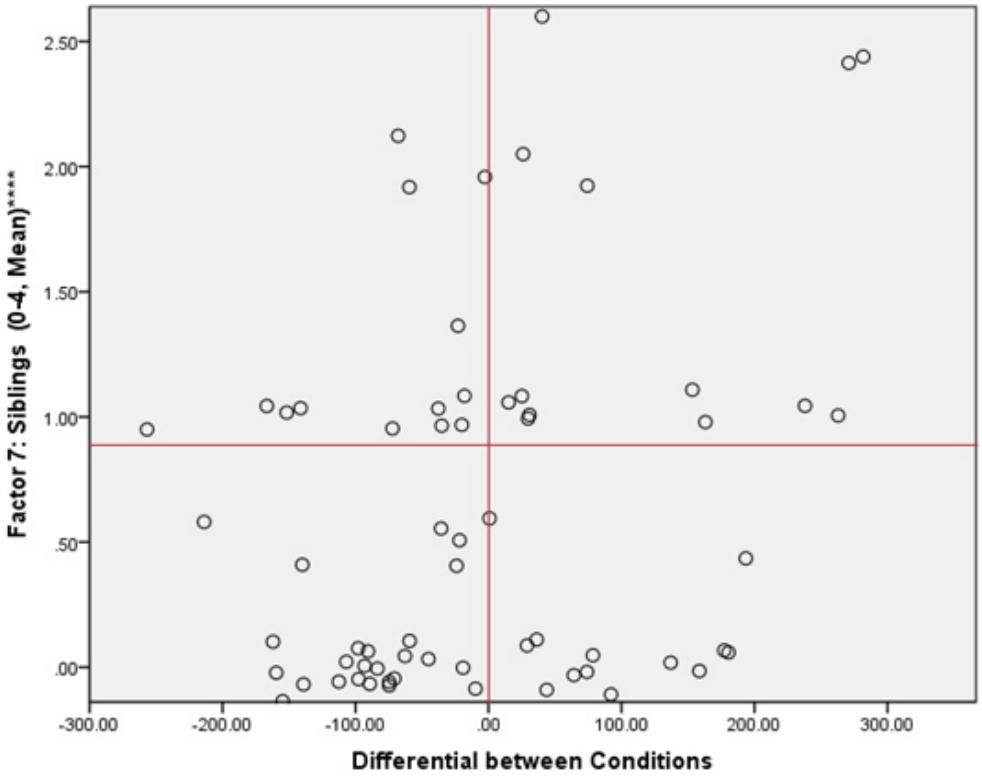



**Figure 14 Use with Siblings and Differential**



### 4.4.16. **Bilinguals with Faster RTs in the Related Condition**

Analysis next explored characteristics of the ten bilingual participants with more rapid RTs in the Related Condition, i.e. those who had been able to dismiss the Punjabi distracter phoneme even more rapidly than the unrelated phoneme. As detailed in Section 4.4.13, bilingual speakers were categorised within this group if their Related Condition RTs were more than 10% faster than their Unrelated Condition RTs.

As these participants numbered only ten, exploration was by means of descriptive statistics. Demographic characteristics of the ten participants including age, sex, regional residence in the UK and education levels are presented in Table 26. The ten participants exhibited a range in age, sex, education levels, regional residence, faith background and regional origin of their Punjabi. Mean percentage scores in knowledge of the 20 Punjabi words (described in Section 4.4.10) for the ten speakers were similar to the remainder of the bilinguals: the ten participants had a mean score of 87.8% while the remaining bilinguals had a mean score of 90%.

**Table 26 Demographic profile of the ten bilinguals with faster RTs in Related Condition**

| Participant Number | Sex | Age | Region of UK | Education Level | Religion | Parents born in UK | Origin of the Punjabi |
|---|---|---|---|---|---|---|---|
| 9 | F | 30 | Leicester | Postgraduate degree | Sikh | Neither | India |
| 13 | F | 40 | Leicester | A level | Sikh | Neither | India |
| 15 | M | 40 | Leicester | Postgraduate degree | Muslim | Neither | Pakistan |
| 17 | F | 1 | Birmingham | Bachelor degree | Sikh | Neither | India |
| 20 | M | 34 | Birmingham | Postgraduate degree | Sikh | Neither | India |
| 29 | F | 24 | Thames Valley | Bachelor degree | Muslim | Neither | Pakistan |
| 30 | F | 20 | Thames Valley | Bachelor degree | Muslim | Neither | Pakistan |
| 48 | F | 33 | Thames Valley | Bachelor degree | Sikh | Neither | Pakistan |
| 49 | M | 35 | Thames Valley | Postgraduate degree | Sikh | Neither | India |
| 64 | M | 33 | Leicester | A level | Sikh | Neither | Kenya |

*Spouses.* Of the ten participants, three reported having no partner/spouse and two reported having a partner with whom they used only English. Of the remaining five, three spoke mainly English but some Punjabi with their partner, one used both languages equally and the fifth spoke mainly Punjabi with their partner. (Eighteen of the other 54 English-Punjabi bilinguals had a partner with whom they

used differing degrees of Punjabi, while 18 had a partner with whom they used only English and a further 18 reported no partner.)

*Children.* Of the ten participants, five reported not having children and two spoken only English with their children. Of the remaining three, two spoke mainly English but some Punjabi with their children and one spoke mainly Punjabi with their children. (29 out of the remaining 54 bilinguals reported no children and 12 had children but used no Punjabi with them. Thirteen reported some, varying, degree of Punjabi use with their children.)

*Frequency of Punjabi Use*. Tables 27 and 28 report the frequency with which the ten participants spoke and heard Punjabi in comparison to the remaining 54 bilingual speakers. Seven of the ten participants used Punjabi on a daily basis

**Table 27 Comparative Frequency of Hearing Punjabi**

| Group | Every day | 1-5 times a week | 2-3 times a week | Once a week | Once a month or less |
|---|---|---|---|---|---|
| 10 | 70.0% | 20.0% | 0% | 10% | 0% |
| 54 | 59.3% | 5.6% | 7.4% | 6% | 22% |

**Table 28 Comparative Frequency of Speaking Punjabi**

| Group | Every day | 1-5 times a week | 2-3 times a week | Once a week | Once a month or less |
|---|---|---|---|---|---|
| 10 | 70% | 20% | 0% | 10% | 0% |
| 54 | 57% | 6% | 7% | 7% | 22% |

*Interlocutors.* Boxplots below (Figures 15-21) illustrate comparative usage with each of the seven aggregated interlocutor variables described in Section 4.1.4 for the ten participants in comparison to the remaining 54 bilingual speakers (labelled 'Faster or 54'). The ten participants have higher median use of Punjabi with five of the interlocutors (friends, spouses/children, fathers, neighbours/colleagues and siblings). Median use of Punjabi with mothers was similar across groups and the ten participants' median use of Punjabi with elder relatives was lower than for the remaining 54 bilingual speakers.

**Figure 15 Comparative Interlocutor Usage: Friends**

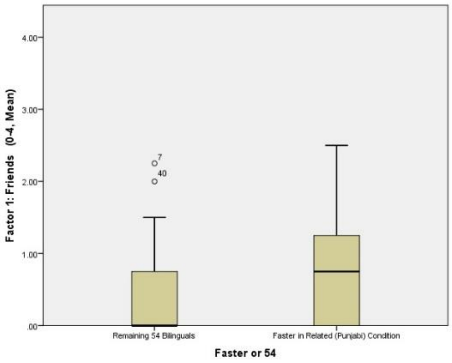



**Figure 26 Comparative Interlocutor Usage: Fathers**

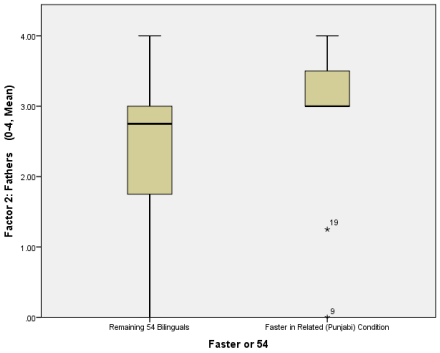



**Figure 37 Comparative Interlocutor Usage: Spouse and Children**

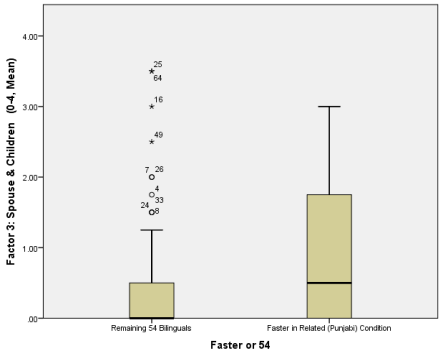



**Figure 48 Comparative Interlocutor Usage: Elders**

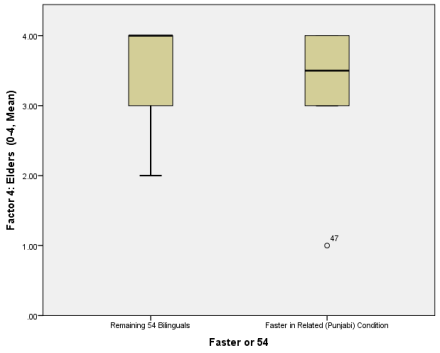



**Figure 59 Comparative Interlocutor Usage: Neighbours and Colleagues**

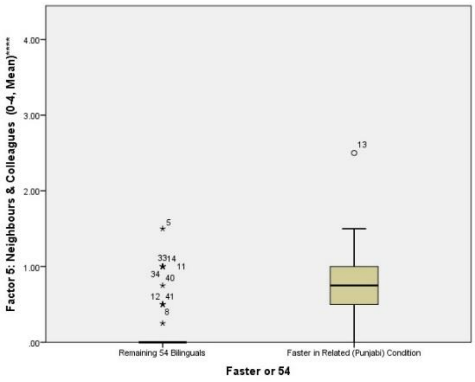



**Figure 20 Comparative Interlocutor Usage: Mothers**

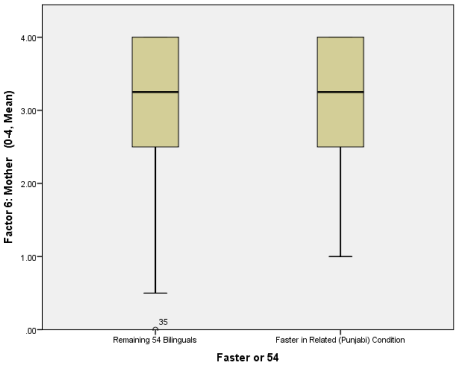
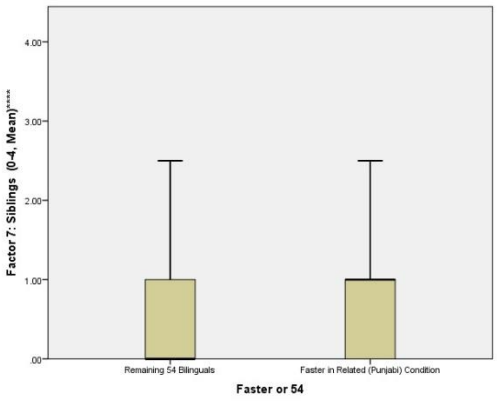


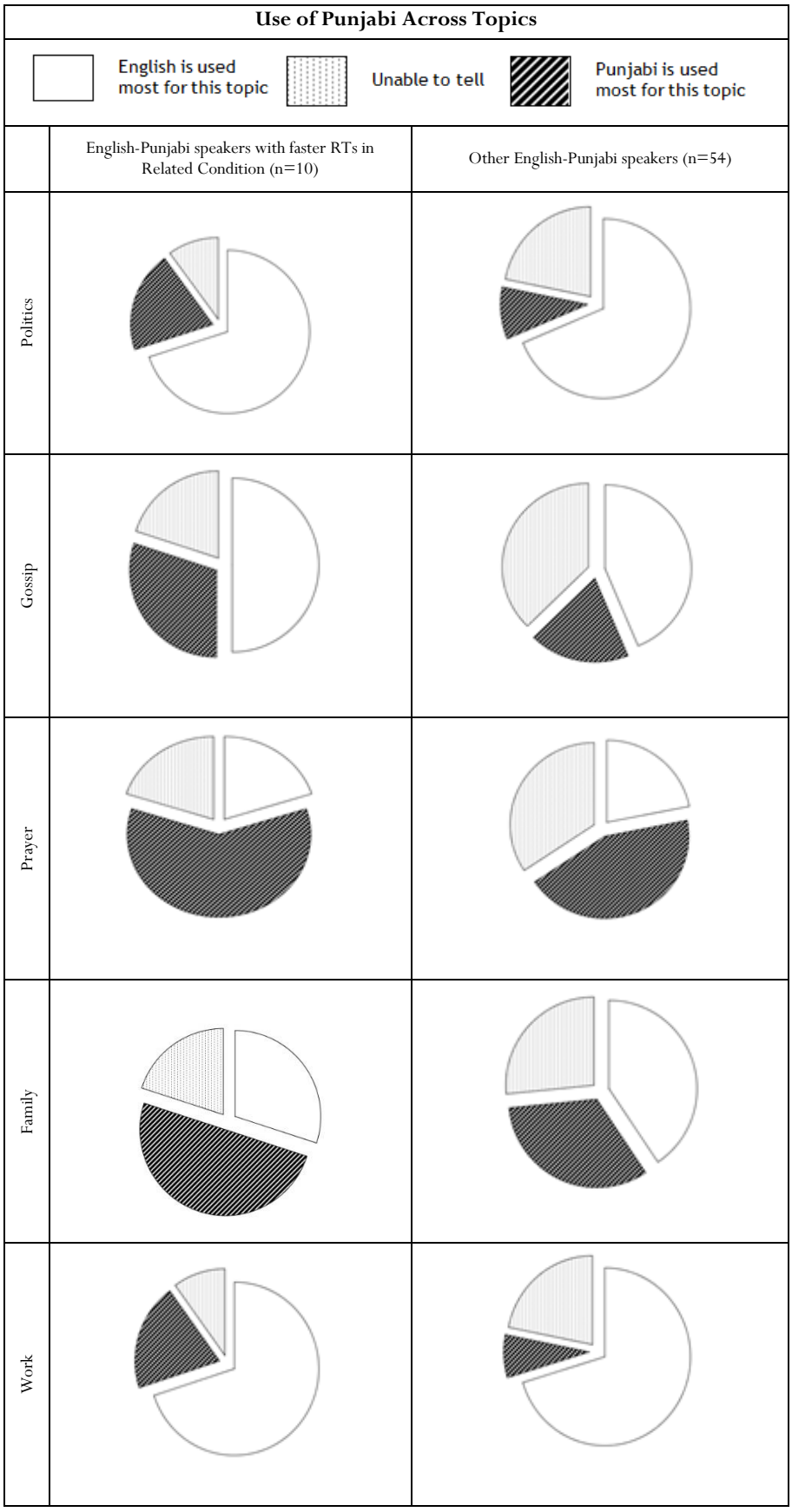
**Figure 21 Comparative Interlocutor Usage: Siblings**




*Use of Punjabi in Different Topics.* Figure 22 presents comparative pie chart illustration of speakers' use of Punjabi across different topics. The left hand column illustrates use across topics by the ten participants with faster RTs in the Related Condition, while the right hand column illustrates use for the remaining 54 bilinguals. The darkest shading indicates that Punjabi is the language of choice for the topic in question. Across all topics, the percentage of responses indicating Punjabi is most used for the topic is higher among the ten participants.

The results presented above are next discussed in the final chapter.

**Figure 22 Use of Punjabi across Topics**



# Chapter 5. Discussion & Conclusion

The final chapter of this thesis discusses the main results presented in Chapter 4. This study has sought evidence for the activation of non-target lexemes by comparing monolingual and bilingual experimental groups' performance in a phoneme monitoring experiment and conducting further analysis of within-group variance. The first research question asked whether, during language processing in a dominant language, a less-dominant, non-target language is also active at the lexeme level. The second research question explored whether language usage patterns might influence whether or not the non-target language is activated.

## 5.1. Does Co-Activation of the Non-Target Language Extend to Phonological Levels?

Where Colomé (2001) found evidence of interference from the non-target language, this has not been replicated in the current study. At group level, bilinguals in the current study responded significantly more slowly than monolinguals, but the lack of interaction effect between group and condition provides no evidence for group level interference from Punjabi distracters. As significance was not reached, the null hypothesis of the first research question (non-activation of Punjabi) cannot be discarded.

The group level result could be seen to be consistent with the non-target language not being activated to the lexeme level when speakers of a less dominant community language produce speech in a dominant environmental language (which cannot be confirmed without further analysis). Such a result would not be cause for surprise. Population differences between Catalan-Spanish and English-Punjabi bilinguals are considerable and are consistent with the possibility of different activation patterns for the respective non-target languages, Catalan and Punjabi. As discussed at various points above, Catalan-Spanish bilinguals in Catalonia receive formal education in and through both languages with a requirement that a certain level of proficiency is reached in both and therefore have closer levels of dominance across languages. Both languages also feature, to different extents, in everyday public life in

Catalonia (i.e. Catalan is not considered to be subject to the same restrictions outside the home domain that apply to Punjabi) and the structural distance between Catalan and Spanish is not great.

English-Punjabi bilinguals in the UK present a markedly different linguistic profile. There is no formal state education in non-English mother tongues in the UK and speaker accounts (described in Section 4.1.3 on interlocutor driven language choice) suggest the school environment is not conducive to use of languages other than English, in line with comments from other researchers on the challenging environment of English schools for children from linguistic minorities (Stuart-Smith & Martin, 1998). Most speakers have neither formally studied Punjabi nor received formal education through the medium of Punjabi. The monoliteracy of these bilinguals, which largely extends to their parents,[21] limits vocabulary acquisition and use of Punjabi for educated purposes and interviews suggest that Punjabi use is mainly restricted to a single domain of home and family, where it is squeezed by English and Urdu (see Section 4.1.3). Given this overall profile, it is entirely plausible that the Punjabi generally receives little activation outside its core domains of use, such as the home. Despite influences towards Punjabi activation, in the form of recruitment process and accent traces in the auditory stimuli, conclusive evidence for co-activation was not produced (discussed further in Section 5.7).

Notwithstanding the plausibility that mental representations for Punjabi lexical items would not be accessed during the experimental task, detailed exploration of variance has revealed a more complex processing picture. The degree of variance in experimental performance was greater among bilinguals than monolinguals, with the standard deviation for bilingual mean reaction times almost double that of monolingual participants (see Table 21). In this regard, bilingual processing in this data does not resemble monolingual processing, as would be the case if Punjabi representations were not accessed during the experimental task and were not impacting on English processing. This variance occurred despite controls applied to the sample and good levels of homogeneity in key factors including English dominance, frequency of Punjabi use, UK birth and residence, monoliteracy and age of acquisition.

Another complexity in the bilingual data was that examination of RT differentials showed different patterns for monolinguals and bilinguals (see Figure 8 and Section 4.4.16). Differential percentages (the absolute RT difference, divided by the Unrelated) were below 10% for most

[21] Phonemic decoding skills in Koranic Arabic with no underpinning lexical access are not considered under the term literacy here.

monolinguals. In contrast, just over a quarter (n=17) of bilinguals were more than 10% slower in the Related condition than the Unrelated, while 15.6% (n=10) were more than 10% faster in the Related Condition than the Unrelated. This finding in particular is unexpected, as activation of the non-target language was manifested only as interference in Colomé's (2001) study; faster responses in the Related Condition were not expected. The spread of differential for bilinguals raises the possibility of varying activation states among the bilingual participants, but, as it is not possible to verify on an individual-by-individual basis whether each speaker is accessing Punjabi representations, this cannot be confirmed. A further, critical pattern in the bilingual data was found in response to research question two (discussed in the next section) - fine-grained patterns of Punjabi use were shown to account for a third of the variance in RT differentials for bilinguals (Section 4.4.15).

It is difficult to reconcile this pattern – indicating considerable bilingual processing variance in comparison to monolingual data and the ability for Punjabi usage patterns to predict a third of processing variance - with a processing scenario in which Punjabi representations were not accessed by participants during the experiment. If Punjabi lexemes were not activated during the experimental task, Punjabi usage patterns should not be able to predict, even partially, speed of response to Punjabi distracters. Overall, result for research question one must be considered to be inconclusive: on the one hand the lack of significant group by condition interaction provides no evidence for group level activation of Punjabi, while on the other bilingual variance patterns and the ability for language use patterns to account for some of the variance in processing raise the possibility that activation states in bilinguals may have varied.

It is not clear why RT patterns in the current study included some speakers dismissing the Related phoneme more rapidly than the Unrelated. In Colomé's (2001) study, which did not measure usage variance within the bilingual groups, only interference was reported. Here, patterns indicate that use of the non-target language in a number of measures (e.g. with certain interlocutors) positively correlates with the speed with which the Punjabi/Related phoneme is dismissed. One speculative possible explanation for faster Related RTs in participants with greater use of Punjabi could be the nature of the task demand. Phoneme monitoring, as well as being an online processing paradigm, also requires an element of conscious monitoring. Specifically, it requires participants to monitor the name

of a picture and compare its phonology with that of an abstract linguistic unit (an auditory phoneme). If participants become aware of Punjabi interference, it could be hypothesised that they might start to consciously monitor both the Punjabi as well as the English picture name. In common with Colomé (2001), the design encouraged participants to monitor the whole English word (see filler condition English 2, Section 3.5). However, Punjabi distracter phonemes were always word onset, and so certain speakers may have been able to reject the phoneme even more rapidly than a monolingual. This speculation cannot, however, be confirmed.

## 5.2. Fine-Grained Language Usage and Adaptive Processing

Research question two of the study explored whether language usage patterns might influence co-activation of the non-target language. Specifically, the study has assessed impact on the differential RT by a range of sociolinguistic speaker profile factors. A set of language use predictor variables was aggregated from raw survey data; this process was informed by interviews with a subset of bilingual participants which suggested an important role for interlocutors and was also aided by use of Principal Component Analysis

Nine language use predictor variables were tested for possible associations with the differential RT. Two predictor variables, both based on use of Punjabi with specific interlocutors, were associated with RT variance: participants' language use with siblings and participants' language use with their neighbours and colleagues. Inspection of the direction of the effect showed that marginally increased use of Punjabi with these interlocutors was associated with more rapid dismissal of the Punjabi distracter phoneme. The direction of the effects found in regression analysis suggests that those speakers with slightly increased use of Punjabi in these interlocutor categories suffered less interference costs than other speakers. Hence, increased usage was interestingly not associated with greater costs.

Other possible associations between usage and differential RT were explored through correlation analysis and descriptive statistics. There was no correlation between age of participants and any RT measures. One interpretation of a correlation could have been the possibility that older speakers who had, by virtue of their age, been using Punjabi for a longer period of time would experience more interference, but this association was not found.

Though no individual topic correlated with differential RT for the bilingual group as a whole (Table 22), there was a correlation between the overall score for Punjabi use across all five topics and differential RT. A scatterplot was inspected in order to ascertain the direction of the effect (Figure 9). Data were consistent with slight increases in Punjabi usage being associated with more rapid dismissal of the Punjabi distracter phoneme.

Some interlocutor categories, including mother and elders, showed no correlation with differential RT even though these particular interlocutors might be conjectured to be critically important to maintenance and active use of a home language. One possible reason for the lack of effect could be that participants' use of Punjabi is generally high with these interlocutors and therefore presents less spread. As reported in Table 11, more than 70% of bilinguals reported using mainly or only Punjabi in interactions with their mother and 89% reported the same for interactions with elder relatives. In contrast, less than half of the participants reported the same pattern for interaction with fathers.

Interestingly, use of Punjabi with fathers did correlate with experimental performance. A scatterplot (presented in Figure 10) was inspected to determine the direction of effect. Patterns were consistent with the possibility of small increases in use of Punjabi with fathers being associated with an increase in the speed with which the participant could dismiss the Punjabi distracter phoneme. The interlocutor category of fathers did not, however, contribute significantly to variance in the multiple regression analysis (Section 4.4.15).

Why does use of Punjabi with fathers correlate with RT differential, while use of Punjabi with mothers does not? Two possible explanations occur. One simple reason could be that there may be more spread in usage patterns with fathers than with mothers (for whom scores are clustered at the higher end). A second possibility, which warrants exploration in future studies, is that different levels of socio-cultural importance are attached to paternal versus maternal language use within Punjabi-speaking families. Further research might consider different ways in which these two interlocutors drive language use patterns of the next generation and whether paternal language choice is particularly influential. This question is beyond the scope of the current study.

It is likewise difficult to verify whether the reason that some interlocutors (e.g. mothers, elders, friends) are not associated with experimental performance is simply due to less spread in usage patterns with these speakers. However, the fact that an interlocutor category which also exhibits little spread (neighbour and colleagues) significantly contributes to processing variance (Section 4.4.15) suggests other factors may also be involved in the relationship between usage and processing.

Two further observations on the interactions between differential RT and usage data. The first is that increases in overall *cumulative* use can be seen to correlate with experimental performance, such as the combination of adult interlocutors presented in Table 23 and the cumulative use of Punjabi across topics presented in Table 22. However individual factors can also play a significant role, as did the interlocutor category of neighbours and colleagues. A second observation is that the pattern which appears at several points in the data is that more use of Punjabi associates with more rapid dismissal of the Punjabi distracter. Individual participant profiles were inspected for the ten participants whose differential RTs indicated particularly swift dismissal of the Punjabi distracter phoneme.

Scrutiny of the ten bilingual participants who dismissed the Punjabi distracter phoneme most rapidly (presented in Section 4.4.16) showed them to have higher median Punjabi usage levels than other bilingual participants in the following language use measures: use of Punjabi with friends (Figure 15); use of Punjabi with fathers (Figure 16); use of Punjabi with spouse and children (Figure 17); use of Punjabi with neighbours and colleagues (Figure 19); and use of Punjabi with siblings (Figure 21). The percentage of responses indicating that Punjabi was most used for a topic (Figure 22) was compared between the group of ten bilingual participants who dismissed the Punjabi distracter phoneme most rapidly and the other bilinguals; Punjabi was more frequently the most used language among the ten. These results suggest a trend whereby participants with greater use of Punjabi were able to dismiss the distracter phoneme from a cross-language Punjabi competitor word more rapidly.

Taking the differential RT as an index for processing then, usage patterns have been found to show associations with processing. Specific aspects of participants' usage patterns have been able to account for just under a third of the variance in bilingual processing. This result crucially demonstrates that bilingual processing variance is not entirely random, but arises at least partially from adaptations of the language system to different ongoing contexts of language use. The role of fine-grained language

use can often be overlooked in research on bilingual activation, but is argued here to have an under-explored relationship to processing.

The next sub-section considers the relationship between the findings on fine-grained language use and Fishman's (1972) concept of the domain.

### 5.2.1. Domains and the Language System's Preparations for Future Use

The predictive value of the neighbours/colleagues variable is found to be consistent with a long established sociolinguistic theoretical framework for characterising societal delineations in language use, that of language domains. Interview accounts suggest that for the speakers in this study, the stronghold of Punjabi use is located within a single domain of home and family. Interlocutors appear to be one indicator of language domains, helping to determine how speakers see the requirements of the coming language encounter.

The most significant predictor variable to emerge from the regression analysis was a clustered variable containing interlocutor types with whom speakers in this population generally tend *not* to use Punjabi – colleagues and neighbours. (A lower order but also significant effect was also evident for interlocutors with whom speakers commonly use a mixture of languages, their siblings in adulthood.) The particular significance of an interlocutor predictor variable from a domain that usually *excludes* Punjabi supports the idea that using Punjabi in a domain from which it is normally absent may be associated with a change in processing expectations. Regression and correlation results suggest that those bilinguals who use Punjabi (even a little) in the work domain and outside their home in the general neighbourhood may have been able to access the Punjabi competitor item more swiftly than others.

This information provides some insight into possible strategies used by the language system for determining likely future use of each language. Little is known about precisely how the language system determines likely future use requirements, though theories such as Language Mode (Grosjean, 2008) and Activation Threshold Hypothesis (Paradis, 2004) are both squarely based on the view that the system is perpetually adjusting itself so as to be best prepared for the processing demands that are about to be placed on it. The language system's specific operationalization of indicators of likely imminent use are broadly theorised to include such factors as interlocutor, or frequency, among others. As

recounted in Section 2.5.1 above, Grosjean (1998) proposes a set of potential *external* indicators, including interlocutors, hearers, mixing habits, kinship and physical location. This focus on external factors can be contrasted to Paradis' (2004:191) comment that 'the greater availability' of an item may condition speaker choice, suggesting that *internal* processing constraints could drive external language behaviour as much as external factors determining internal activation states. The author of this thesis supports a view of the language system as adjusting itself so as to be best prepared for the processing demands that are about to be placed on it based on external cues, but makes no claim to offer a definitive set of factors for preparation for use. Several possible factors have been introduced in Section 2.5 and 2.5.1. Briefly, these include topic and domain, both of which may be associated with one language over another (Fishman, 1972) and the exhaustive list of factors detailed by Grosjean (2008) in his description of language made, such as the profile of interlocutors and hearers (their proficiency, mixing habits, attitudes, kinship relation, socio-economic status, etc.) the situation, including physical location and whether there are monolinguals nearby, how intimate the speakers are, and a number of other factors.

Results of the regression analysis in this study make some contribution to our limited understanding of likely factors in preparation for use. The most significant predictor variables were not factors relating to cumulative levels of the *total* quantity of Punjabi use, or to overall frequency of Punjabi use. Such factors could very reasonably be expected to impact on processing, with an expectation that the greater the quantity of Punjabi a speaker uses and the more frequently it is used, the higher the expected activation levels of the language (Paradis, 2004). No argument is made here that such factors do not affect activation states – relationships between cumulative quantity of use and processing have been found in the data, such as the combination of adult interlocutors presented in Table 23 and the cumulative use of Punjabi across topics presented in Table 22. However, it is suggested here that the significance of variables like neighbours and colleagues demonstrates these are not the only factors involved. In the case of neighbours and colleagues, an effect is found for relatively small increases in Punjabi use. Crucially, the increases occur in domains in which use of Punjabi is unusual; in interview discussions, work emerged as a physical space in which Punjabi use was seen as firmly inappropriate (reported in Section 4.13). The noteworthy aspect of this finding, therefore, is

that it indicates that even small pockets of additional use in a domain which typically *excludes* the particular language could also impact on activation states.

The theoretical construct of a domain is conceptualised as a high level overview of clusters of interactions and clusters of interlocutors (Fishman, 1972). It can be expected that the language system, experiencing that Punjabi is rarely used outside a home/family domain, is unlikely to prepare Punjabi for imminent use in those contexts. The domains that assertively proscribe against Punjabi use (e.g. school and work) might be seen as arenas in which the language system is particularly likely to categorise use of Punjabi as unlikely. Speakers who do make some use of Punjabi in such domains, may subsequently be more likely to maintain some activation of the language in readiness for use in a work domain, probably manifested as a lower threshold of activation for Punjabi. Such pockets of additional use could conceivably do more to amend the language system's expectations for future use than small incremental changes in other domains, because it may change the pattern of compartmental language use. This possibility is consistent with the lower level of effect for siblings, which reflects a cumulative difference in usage rather than a difference of domain. A domain lens on the results could, on this basis, explain why the most important interlocutor variable involved use of Punjabi in domains that normally strongly proscribe against its use (in employment settings).

Speculatively, this conjecture suggests that some usage indicators could operate compartmentally rather than cumulatively. In a cumulative usage view, the more a language is used, the lower its activation thresholds become (a linear relationship). In a compartmental view, a domain of use can be compared to a room within a building. The language system understands that language x is never used in a certain room and therefore whenever the speaker is in that room the language is not held in readiness for use. If, however, language x starts to be used in the room, even occasionally, this compartmental pattern may change. In such a scenario, a small amount of additional use in unexpected domains could have a disproportionate effect on processing.

This finding is therefore argued to generate interesting hypotheses for future research. It is cautiously proposed here that the patterning of usage usefully captured by the sociolinguistic idea of domain could coincide with some (but by no means all) of the patterning utilised by the language system

to predict and prepare for likely future use of each language, a possibility which is not out of line with core theories postulating that readiness to speak different languages shifts according to certain factors.

Language choice and habitual language patterning in linguistic domains can be seen to arise from influences that are external to the language system and which are social and pragmatic in nature. The fact that predictor variables based on such external factors were significantly associated with processing variance demonstrates that external, *social* contexts may impact upon activation states. Given that the language system does not operate in isolation from wider cognition, but works co-operatively with other functions such as the processing of pragmatic information, it should not be controversial to suggest that the socio-pragmatic landscape within which language is enacted may impact upon language processing itself. The results of examining variance in this study suggest that the social and pragmatic landscape in which speech occurs is likely to be associated with some of the variance in language processing.

Overall, in light of these results, the specificity and complexity of fine-grained language use is argued to be considerably under-explored in studies of activation states. At a theoretical level, bilingual variance should not be a cause for surprise and there is strong reason to expect to find complexity in processing, as the remark below reminds us.

> 'The memory of every individual is likely to contain structures of various types and these structures will occur in different proportions across bilinguals….In sum, one should be extremely wary of discrete classifications that do not do full justice to the representational and processing complexity found within the individual bilingual.' (Grosjean, 1998: 144)

Processing for speakers in the same linguistic population does not appear to operate along identical lines and this is consistent with views, such as that above, of the language system as adaptive to external cues and requirements. Specifically, clustered interlocutor types (which are consistent with domain delineations) appear to operate as one facet by which the language systems in the speakers here studied establish expectations for language requirements. In this view, marked, out-of-norm domain usage may associate with subtle shifts in activation state, as the system registers that a language which was previously very unlikely to be used in circumstances, such as the workplace, may now be required in

those contexts. No argument is made that domain operates as an exclusive or high-level determiner of activation state. The data is rather argued to present one example of several possible relationships between fine-grained language usage and processing. Detailed examination of usage patterns of the speakers under study is argued to have yielded an enhanced insight into the complexity of processing patterns and to the adaptiveness of the language system.

An alternative reading of the data could be that the interlocutor clusters generated by principal component analysis are simply those interlocutors who serendipitously contributed to increased cumulative usage, unrelated to domain delineations, and that the important feature of the variable is that it presents greater *cumulative* use of Punjabi; in such a reading, the picture of an adaptive language system responding to fine-grained usage holds. The proposed relationship may be more than an adaptation to cumulative frequency however; rather than a simple matter of activation patterns responding to how often items are used, it may be the case that situational and contextual as well as frequency factors all contribute to the management of activation thresholds.

### 5.2.2. **Universals and Variance**

This study has foregrounded variance as an important component of bilingual processing and challenges the notion that all speakers in a given linguistic population will necessarily always present identical processing patterns given an adaptive language system finely tuned to ever-shifting linguistic contexts. Such a view is consistent with a small number of researchers highlighting the importance of bilingual heterogeneity. Kaushanskaya and Prior (2015), for instance, have urged bilingualism researchers to consider developing continuous variables operating within bilingualism and to move away from categorical group designs. Luk (2015) has proposed that monolingualism and bilingualism could present extreme ends of a spectrum, while Wu and Thierry (2013) suggest that immediate linguistic context may have an online interaction with cognitive function, implying that very recent language usage/exposure could affect not only linguistic processing, but also domain general non-linguistic cognitive function.

Notwithstanding the importance of examining variance, however, the architecture of the language system remains a fundamental universal in language processing. The current study contains

no proposal of variance in this underpinning architecture, but simply proposes that the system's adaptiveness to complex language environments entails the possibility of variance in activation states.

The next section examines the importance of research bilingual activation states in speakers whose languages are under pressure.

## 5.3. Co-Activation in Atypical Linguistic Populations

Earlier sections of this thesis (e.g. Section 2.7.4 and Chapter 1) have described the ways in which the linguistic population chosen for this study can be viewed as atypical (in relation to activation research), under pressure and methodologically challenging, while also a strategically interesting choice for this research. Findings, in particular from interview discussions, have reinforced the initial picture of Punjabi as a squeezed language in the British context. Interview informants touch on a number of ways in which the language is under pressure. School and work tend to proscribe against Punjabi use, both in participants' childhoods, where they are taught to 'keep the Punjabi below and keep the English at the top,' and in parenting of their own children where school-related concerns may encourage them to reduce use of Punjabi in the home. Some speakers feel that mono-literacy presents a glass ceiling on their Punjabi competence so that it is difficult to cover all topics they might wish to discuss in Punjabi. One informant described a pressure arising from transnational arranged marriages to Urdu-speaking partners which create competition from Urdu in Punjabi's strongest domain, the home. Survey data from this study present a picture of language use in which Punjabi dominates few categories of conversation is used less with younger generations than older ones.

The squeezed nature of Punjabi in the British context adds to its interest as a focus for research on bilingual processing. While Gardner-Chloros (1991:47) affirms that the 'fiction' of the ideal speaker has (rightly, in the current author's view) been abandoned by linguists and sociolinguists, the shadow of the ideal speaker still looms large over research on language processing. Attempting to evidence deep level co-activation in a population of the nature featured in this research has been shown to be methodologically challenging, nonetheless research on this question has a broad application, not only to the context of bilingualism in the UK, but to any linguistic context where the degree to which smaller or threatened languages are still cognitively active is uncertain. More research is needed to open up the

question of activation states in populations presenting a 'messier' language relationship than the neater presentation of the ideal speaker.

The possibility of mixed code development in British Punjabi, which has been suggested by previous studies (e.g. Reynolds, 2002), adds to the overall interest of the population. Section 2.7.4 introduced the possibility that in some areas of the UK Punjabi has absorbed English to such a degree that it is becoming a mixed code. The current study can neither confirm nor rule this out, but acknowledges the possibility of mixed code development in Punjabi. The processing implications of speaking a mixed code are unclear. However it is uncertain what specific impact a high degree of English lexis in the code may have had on the experimental results presented here given that analysis only featured Punjabi competitor words which were known to the participants. As a hypothetical example, it may be the case that the English word 'window' has replaced its Punjabi equivalent. The analysis accounts for this eventuality by excluding those trials from analysis because the word was not known to the participant. As discussed in Section 2.7.4, if the mixed code is considerably influenced by the speaker's other language, the structural distance between the two speaker's languages must be considered to be substantially reduced. Reduced structural distance might, hypothetically, influence the degree of co-activation compared to language pairs containing much greater structural distance. During naturalistic use of a Punjabi variety which has been heavily influenced by English lexis, it could be anticipated that lexical representations which serve both English and Punjabi would be accessed, though the phonetic features in articulation of shared words such as 'shop' or 'tomato' would vary considerably between Standard English and a mixed Punjabi/English code; shared lexical items of this kind were, however, avoided in the experiment presented in this thesis. An issue more likely to have impacted on experimental results in some way is the possibility that the auditory stimuli contained detectable accent traces; this is discussed in relation to the language mode of the participants in Section 5.7.

Firm evidence of Punjabi co-activation in light of the population profile would have been of considerable interest. An accurate picture of activation states at the phonological level in different population patterns would, in some senses, complete existing knowledge of bilingual co-activation in word production throughout the levels of representation. Colomé and Miozzo (2010) make a similar

argument to this, on the basis that all other levels have already been accessed by this point. As results are not conclusive as to whether Punjabi speakers co-active Punjabi lexemes while performing tasks in English (research question one), this question remains an important one for the field to explore further. The study does, however, firmly establish a link between fine-grained language usage and processing patterns in speakers of a language under pressure (research question two).

### 5.4. **Relationship to Previous Studies**

Several previous studies have demonstrated non-target lexeme activation in different population profiles. For instance, Colomé (2001) and Colomé and Miozzo (2010) evidenced non-target phonological activation in near-balanced speakers. While Colomé's earlier study was criticised by Costa and colleagues' (2006), who believed that phoneme monitoring would lead to the activation of a whole language, such a view is not supported by the absence of conclusive, group-level activation in the current study. Wu and Thierry (2011) found that speaking in weaker L2 English involved activation of L1 Chinese, but speaking in Chinese did not involve activation of L2 English. Wu and Thierry's participants began learning English from age 12, had been in the UK for an average of 18 months at the time of the experiment and their maximum age at the time of the study was 23. A number of other previous studies, including Hoshino and Thierry (2011), Wu and Thierry (2012) and Spalek and colleagues (2014), among others, have found support for non-target language phonological activation when the language of production is a weaker second language and the non-target language is a stronger first language. The current study cannot conclusively confirm whether activation occurs in the reverse scenario, i.e. when the language of production is a very securely dominant environmental language and the non-target language is a non-dominant community language under pressure. The study does, however, contribute to the picture of non-target phonological activation by establishing a link between the detailed, habitual language use of speakers and their language processing. The exploration of bilingual variance within a single population, which exceeds that of any of the studies reviewed, demonstrates that operationalising linguistic populations as a group without exploring internal variance due to the fine-grained usage differences may have shortcomings.

## 5.5. Potential Confounds

It is important to assess the possibilities for this pattern of results to have occurred due to confounds. A number of areas in which the author believes potential confounds have been avoided are discussed in this section, while Section 5.7 discusses accepted limitations to the study.

As a first consideration, the study has made a deliberate choice to focus on bilinguals far removed from the (mostly disregarded) notion of the 'ideal' speaker whose languages are symmetrical in terms of proficiency, dominance and use. Given the pressures on speakers' Punjabi in terms of lack of support in the UK context, pressures towards monolingualism in the educational system and poor prestige, it is possible to question whether speakers' Punjabi proficiency was simply too low for activation to have occurred, or for the participants to be considered fully bilingual.

For reasons given in Section 2.7.2, higher priority here has been accorded to measuring language use than to traditional proficiency measures. Certain commonalities across participants could be seen to indicate broadly low proficiency in formal terms: zero formal instruction in Punjabi; zero education through the medium of Punjabi; Punjabi not being used as the main language of employment; Punjabi non-dominance; zero use of Punjabi for literacy; limited domains of use for Punjabi. However, these factors are importantly combined with regular use of Punjabi for nuanced, culturally-specific communication in an authentic speech community. Other researchers (Cabo & Rothman, 2012; Rothman & Treffers-Daller, 2014) have underlined the significance of authentic use within a real speech community by heritage bilinguals and argue that their proficiency levels may closely represent the input received, even if different to monolingual norms, and does not therefore represent incomplete acquisition. They further argue that the valid point of comparison for such speakers' language is with first generation members of the same population. Stuart-Smith and Martin (1999) provide further indication that the community variety of Punjabi in which young speakers of British Punjabi are proficient differs to standard Punjabi and has absorbed more English lexis.

Had the overall level of Punjabi proficiency – proficiency, that is, in the heritage form of Punjabi used by the participants - been too low for the speakers to reasonably be considered bilingual, it could be expected that absolute and relative reaction time values would have been closer to the pattern for monolinguals. This has not been the case. An absence of Punjabi proficiency would also have been

unlikely to result in the significantly slower group level reaction times observed for bilingual participants. As a check against inclusion of Punjabi words unknown to the participants, analysis included only those Punjabi words that were known to a participant to ensure the experiment was based on actual and current Punjabi knowledge.

An important cause of confound to rule out is a poorly controlled population. The controls that were applied to the population were standard in research studies on bilingualism and included handessness, dominance, residence and age of acquisition, among other controls. One demographic aspect, the age of the participants, did exhibit a wider range than is common in many studies and this is acknowledged as a limitation (see Section 5.7), though it is not anticipated that age variance could have created the within-group usage effects found.

Wu and Thierry (2010) have advised studies on co-activation to account for seven questions related to the possibility for experimental language context to impact on results. These seven elements are briefly referenced here. The current study did not (Q1) explicitly require participants to retrieve representations from Punjabi. Nor were language stimuli in the current study explicitly part of the non-target language (Q2), as are distracters in picture-word interference paradigms. As outlined in Section 3.5.1, the many cognates and loan words shared by English and Punjabi (e.g. 'tomato,' 'shop') were carefully avoided. The single phonemes used in this study attempted to avoid overt Punjabi accent features such as hard on/off aspiration in plosives employing contrastive aspiration; in informal post-experiment feedback participants reported that they were not explicitly conscious of a British Asian speaker. However it is acknowledged that the stimuli are likely to have contained some *implicitly* detectable traces of British Asian accent features. The distance between the two languages employed in the study (Q3) is sufficient to detract from major concerns that speakers are unable to operate monolingually due to the similarity; though there are many English loan words and the possibility of Punjabi developing into a mixed code is acknowledged (Reynolds, 2002), which may substantially reduce the structural distance between languages. Analysis has explored bilingual performance (Q4) from both within- and between-group perspectives, to yield greater insights into the variation within the bilingual speakers.

Wu and Thierry's advice to debrief participants at the end of experiments about their awareness of the bilingual nature of the task (Q5) was not systematically followed in the current study (due to publication date and the data already having been collected), however the post-task comments made by participants to the author suggest this practice would offer advantages. It is not possible to say whether bilingual participants were explicitly aware of the nature of the design, but many comments were consistent with Punjabi activation. A systematic collection of participant perceptions could have been cross-referenced with experimental outcome as an aid to determining likely activation status, or interpreting the reason for some participants to have produced faster reaction times in the Related condition. The potential contextual elements of the design (Q6) to have impacted on results has been partially discussed in relation to recruitment in Section 3.2; instructions, lab setting, experimenter, etc., were purely in English and the author was known to participants to be a non-Punjabi speaker.

Wu and Thierry's (2010) final advice (Q7) was for studies to consider the interaction of risk factors for confounding effects. Overall, confound risks for the current study are argued to be low in terms of the experimental setting. Recruitment practice remains a stubbornly difficult problem to eradicate, which may well have produced some level of Punjabi activation when bilingual participants arrived for the study. However, sources of confound from the study itself have been carefully minimised where possible; the explicit task requirements, the visual stimuli deployed and the instructions/experimenter setting were all highly monolingual. A more pertinent issue is possible influence of auditory stimuli and overall impact on speaker's position on the language mode (Grosjean, 2008), discussed in section 5.7.

## 5.6. **Summary of Findings**

Overall, results for research question are inconclusive as to whether non-target language lexemes were co-activated. It may be possible that different individuals were accessing Punjabi representations while others were not, but without a means of establishing individual activation states, such a possibility cannot be verified. The key finding of the study results from research question two.

Usage-based predictor variables have been able to account for just under a third of the variance in bilingual experimental performance, with two clustered interlocutor variables (neighbours/colleagues and siblings in adulthood) significantly contributing to differentials between condition. Slightly

increased usage of Punjabi with these interlocutors has been associated with less interference from Punjabi during the experiment, rather than more. The contribution of these factors to variance demonstrates that processing variance is not random, but can arise at least partially from different usage patterns. The contribution of the neighbours/colleagues factor to processing variance raises the possibility that increased use of Punjabi in a linguistic domain which normally proscribes against its use is significant and that linguistic domain may be salient information for the language system, contributing to its ability to predict likely imminent language demands.

As well as predicting some of the variance in processing, other associations were found between fine-grained usage variables and language processing. Some of the pertinent variables reflected cumulative use, such as combined use of the non-target language across topics, but a number indicated individual usage measures, such as use of Punjabi with fathers. In all associations found, the direction of effect indicated that increases in Punjabi usage were moderately associated with more rapid dismissal of the non-target distracter phoneme.

The results of research question two are interpreted as indicating a relationship between fine-grained usage and activation states and to point to a need for greater exploration of how the language system adapts to contextual, situational, social and pragmatic patterns of language use.

## 5.7. **Limitations**

This section outlines a number of accepted limitations to the study.

A considerable limitation is that the current study contains a single experiment with no replication. While research question two has yielded considerable information about language usage, the analysis presented cannot conclusively answer research question one. Results may be consistent with the possibility of a range of activation states, but the study is not able to determine co-activation at an individual level. Further exploration of the possibility for varied activation states within a single population is still needed. One manipulation to the current design which might disambiguate the contradictory activation picture could be grouping the Punjabi speakers according to fine-grained usage. Patterns in the correlation and regression data suggest that fine-grained usage positively associates with processing. Therefore future designs could operationalise fine-grained usage as a categorical variable and group speakers according to detailed usage profiles. Particular attention would need to be given to

usage differences involving use of a language in domains where its use is atypical. For instance, usage categories could distinguish between English-Punjabi speakers who never use English in the workplace and those who do so regularly. Alternatively, if children were the subject of study, research might compare children at schools which strongly proscribe against use of Punjabi in the classroom and playground with highly mixed schools where the environment is more amenable to Punjabi use. In such a design, comparing two groups of broadly similar bilingual speakers differentiated only by fine-grained usage differences, different activation patterns could be anticipated. Based on the results for research question two, it could specifically be expected that the bilingual group with greater use of Punjabi, particularly outside expected domains, might show more evidence of co-activation.

Given the possibility for development of a mixed code, a comparison between Punjabi speakers and another linguistic population in which the two languages are less mixed might be beneficial. An ideal comparison population might involve a pairing of English with a less squeezed language (perhaps involving new migrant groups in the UK, e.g. Polish speakers), determining whether there is stronger evidence for phonological co-activation in the less mixed language.

In the current study, though the intention was to prepare auditory stimuli which were relatively neutral across languages, it is likely that subtle traces of British Asian accent features remained, as mentioned in the sub-section on auditory stimuli, below. A future study might present stimuli spoken by speakers with varying accents (e.g. Estuary English, markedly Punjabi accents, Received Pronunciation) to investigate whether evidence for activation of Punjabi is found with detectably British Asian accents, but not other British accents.

Though the study has contributed to understanding of how usage patterns might interact with processing, it does not claim to have identified all usage factors. The nature of the heritage speaker population profile has rendered proficiency a highly problematic measure and, rather than deploy weak measures, this study has focussed on the importance of usage over proficiency. Other researchers may wish to undertake parallel explorations of how subtle differentiations in heritage speakers' oral and culturally-specific proficiency in a community language could impact on processing variance. Speakers' attitudes to heritage languages and the prestige accorded to them are also considered a rich area for similar exploration.

A processing role for intra-sentential code-switching is also emphatically not ruled out given its requirement for highly controlled access in combination with clause-by-clause inhibition. The self-reported nature of the qualitative data does not permit valid operationalization of a variable on intra-sentential code-switching and it may be the case that only observational data could achieve this. In future psycholinguistic studies, other methods (possibly including longer term observational work) may be needed to capture nuanced profiles of participants' switching behaviour, as may also be the case for further investigation of language domains.

As a pragmatic response to recruitment difficulties, the age range of the participants was wider than usual.

***Limitations arising from aural stimuli***

The limitations of employing orthography are discussed above (Section 2.4) and include issues such as cross-language neighbourhood effects and the possibility that the graphemes presented may not map to sound in identical ways in both languages. For these reasons the current study has replaced orthographic stimuli with auditory ones. However it is acknowledged that the use of auditory stimuli does not offer protection from the kind of complications arising from orthographic stimuli, and may indeed involve even more methodological complexities. Several possible limitations to this study arise from the aural stimuli employed here. For note, as the author of the current study is not a trained phonetician and given that the focus of the thesis is not phonetics, close auditory or acoustic analysis of the stimuli has not been made, as is the case in comparable psycholinguistic studies presenting auditory stimuli, e.g. Hermans and colleagues (1998).

One limitation arising from the auditory stimuli employed is that they may have contained detectable British Asian accent traces. Hawkins (2003) and Clopper and Pisoni (2005), among others, have discussed the possibility for individuals to detect the regional and ethnic identity of speakers. While the speaker producing the auditory stimuli for this study was instructed to produce them in as neutral a manner as possible without significant marking of Punjabi accent features, and while in post-experiment feedback the participants could not explicitly identify the speaker as a Punjabi user, this does not rule out the possibility for *implicit* detection of British Asian accent features by participants. Though in the absence of acoustic analysis of each stimulus it cannot be confirmed, descriptive and error

analysis results reported above (Sections 4.4.7 and 4.4.9) are consistent with the possibility that a small number of phonemes may have contained accent traces. In particular, analysis indicates this may have affected the following phonemes: /l, ʧ , h, t, k, l]. Speculatively, the swifter dismissal of phonemes might indicate that there was sufficient accent trace for them to be associated with Punjabi, thus giving early warning that the correct response was 'no'. Based on other studies, potential causes might include aspiration differences between realisations of /t/ and /k/ in Asian and non-Asian British accents (Ladefoged & Maddieson, 1996). Lambert and colleagues (2007) indicate that in stylised British Asian accents /l/ may include a degree of retraction which can be close to retroflexion in some speakers (the study was specific to British Asians in Glasgow) while in British Asian accents /t/ may be articulated with degrees of retroflexion, particularly in male speakers (Sharma, 2011b).

The issues of accent trace and recruitment both have implications for the likely language mode of the participants. Language mode is conceptualised as a fluid spectrum (Grosjean, 1998) and speakers' positions on the spectrum cannot easily be objectively specified. Participants were recruited to the study on the basis of their history of Punjabi use. Recruitment methods as a source of influence on language mode have been discussed in Section 3.2. Though the stimuli and surroundings were language-neutral and the author is not a Punjabi speaker, careful sampling could not be achieved without mention of Punjabi in recruitment materials. Given the likelihood, due to recruitment and accent traces in the stimuli, that some elements of the research would have moved participants toward bilingual mode, it would be anticipated the participants would show signs of accessing Punjabi mental representations during the experimental task.

One possibility could be that the monolingual aspects of the experimental context were considerable enough to indicate a very low overall probability of imminent Punjabi use and partially reverse any movement towards bilingual mode. Participants were seated alone with a non-Punjabi speaker (the author of this study) in a formal office/educational environment, a domain in which the use of Punjabi would be atypical. Though present, the accent traces may have been subtle; the author is not aware of research evidence demonstrating whether or not detection of Punjabi accent traces on single phonemes can activate a language which is not currently in use.

Another limitation is that the phonological distances between Related/Unrelated phoneme pairs is monitored only through voice, place and manner, which may have left other aspects of phonological similarity unexplored. While a check was performed to ensure that all participants could well recognise and reproduce each phoneme before the start of the experiment, there can be no guarantee that the phonological distance between each Related/Unrelated pair is equal, and indeed it is highly unlikely that there is equidistance across all the pairs. This shortcoming is, however, one which is common across psycholinguistic research.

One further problem is that the WATCH/gharee trail included /g/, which failed to take account of Punjabi's loss of voiced aspirates (Bhatia, 1993; Mobbs, 1985). The correct phoneme for this trial would therefore have been /k/ rather than /g/.

Finally, in the current study no whole words are presented and the auditory stimuli are decontextualized segments based on abstract linguistic units (phonemes) with no communicative function in their own right. The phonemes are realised differently than would be the case in the phonetic environment of whole words, and there would be different articulations in each of the experimental words in which they feature. A degree of abstraction is therefore required by the speaker, and while the study is an attempt to index what might happen in a naturalistic setting (ecological validity) there is no guarantee and we can only speculate whether Punjabi might have undergone more (or less) activation in a natural setting.

## 5.8. **Future Studies and Implications**

It is considered likely that future research on bilingual processing will increasingly encounter and engage with the type of bilingual variance explored here. The current study may be seen as a step forward within an existing trend towards increased awareness that language processing is sensitive and adaptive to context (Hamers & Blanc, 2000). In order to assess the variance and complexity of bilingual processing more effectively, new tools may be required. One difficulty in the current study has been the problem of determining whether a specific individual participant's differential reaction time between experimental conditions definitively differs to monolingual differentials, i.e. whether a certain speaker can be shown, in isolation, to be activating both languages. The development of such tools for activation studies would help to deal with data containing a range of activation states in the same

population. (This proposal is not intended to enter into a fractional view of bilingualism, it simply acknowledges that the only way to demonstrate with validity that a sole bilingual is operating in monolingual mode with single language activation may be to compare them with a norms for speakers with a single language.)

Similarly, the methods for determining whether a certain individual is in bilingual mode remain circumstantial. Individuals can be expected to move continuously in and out of modes, meaning that researchers are only able to make educated inferences about how participants arrive for experiments based on recent usage, experimental stimuli and recruitment methods. The elusiveness of establishing monolingual mode in bilingual speakers means this issue remains a considerable one in the field.

Beyond these methodological points, future studies should continue to build evidence for non-target lexeme level activation through other paradigms, in particular seeking evidence for activation of non-dominant, squeezed languages during production of dominant environmental languages. Continued qualitative assessment of participants' usage patterns should seek further relationships between fine-grained usage and adaptiveness of the language system, including the role of domains of use. Examination of whether delineation by domain is one of the mechanisms contributing to how the language system anticipates and prepares for future language use would be highly beneficial to our growing understanding of contextual processing shifts. More generally, a conscious mining of relevant sociolinguistic theory by psycholinguistic studies of bilingual language processing is considered to have potential benefits.

A possible manipulation to the current design is also presented in Section 5.7.

The key non-academic implications of the current study pertain to the British linguistic environment and its impact on other languages. Participant accounts of language use and history suggest that the British school environment presents a disincentive to language maintenance and exerts a pressure towards monolingualism, while speakers absorb the prevailing attitude that use of Punjabi outside the home is poorly viewed. The lack of educational encounter with Punjabi also appears to limit its development, compounding its restriction to a domestic and familial domain of talk. Despite these adverse conditions, Punjabi continues to be active among second generation speakers and it appears that even small pockets of out-of-norm usage for Punjabi may be associated with shifts in processing

patterns. Therefore, even low-level encounters with Punjabi in a school, neighbourhood or professional setting could be conjectured to have potential impact on its maintenance as an active language. In relation to the matter of language maintenance, one final future direction of research might also be to explore whether methodologies for investigating activation patterns in weaker, non-dominant languages could ever be overlaid with work on the ethnolinguistic vitality of threatened languages (see, for instance, Nettle & Romaine, 2000) so that attrition at a processing level is investigated alongside attrition indexed by usage patterns.

## 5.9. **Conclusions**

This study has explored two parallel questions relating to the processing of a non-dominant community language (Punjabi) under considerable pressure from a dominant environmental language (English). First, the study sought evidence of whether activation would proceed to Punjabi phonological representations while speakers were performing tasks in English. Dual activation at the lemma level has been well-documented in previous studies, with some evidence for lexeme-level activation where the processing language is a weaker L2 or one of two relatively balanced languages. The particular linguistic population featured here has permitted the study to investigate the somewhat counter-intuitive possibility of a non-dominant, squeezed community language that attracts low prestige remaining activated during processing in a securely dominant environmental language. Second, the research has considered the degree to which bilingual processing patterns should be expected to be identical (or highly similar) across speakers in the same linguistic population, with a focus on the potential for fine-grained patterns of language use to contribute to processing variance.

Results for the first research question were inconclusive as to whether Punjabi was activated to the lexeme level, while results for research question two establish a clear link between fine-grained language usage and processing patterns. In line with the idea that language processing may not always be identical between speakers in the same linguistic population, variance within bilingual responses was explored in detail and found to be consistent with the possibility of varying activation states. Fine-grained usage factors were associated with experimental performance, predicting a third of processing variance. Increased use of Punjabi in certain measures was associated with the speed with which Punjabi distracter phonemes could be dismissed.

At a theoretical level, bilingual variance should not be a cause for surprise and there is strong reason to expect to find complexity in processing. Theories such as Language Mode (Grosjean, 2008) and Activation Threshold Hypothesis (Paradis, 2004) contain the idea that the language system is perpetually adjusting itself so as to be best prepared for the processing demands which are about to be placed on it. Nonetheless, empirical evidence of precisely how the language system operationalizes indicators of likely imminent use is scant. The current study establishes the ability of data on fine-grained usage to account for some of the variance in bilingual processing, with predictor variables based on use with different interlocutors accounting for a third of the variance in processing. In light of these results, the specificity and complexity of fine-grained language use is argued to be considerably under-explored in studies of activation states. The study cautiously proposes that the patterning of usage usefully captured by the sociolinguistic idea of domain could coincide with some of the patterns utilised by the language system to predict and prepare for likely future use of each language. Pockets of additional use in unexpected domains might conceivably do more to amend the language system's expectations for future use than small incremental changes in other domains. The current study may be seen as a step forward within attempts to understand how the language system adapts processing to its linguistic landscape.

Ultimately studies such as this one attempt to gauge some of the complexity of what happens in naturally occurring conversational encounters between bilinguals, using the imperfect measures available to researchers. Results here suggest that the ever-shifting social and pragmatic landscape in which speech occurs is integrally connected to ongoing activation states and to the processing of language.

# References

Argyri, E., & Sorace, A. (2007). Crosslinguistic influence and language dominance in older bilingual children. *Bilingualism: Language and Cognition,* 10(01), 79-99.

Baetens Beardsmore, H. (1982). *Bilingualism: Basic Principles*. Clevedon: Tieto.

Baker, C. (2001). *Foundations of bilingual education and bilingualism* (3rd ed.). Clevedon: Multilingual Matters.

Balota, D. A., & Duchek, J. M. (1988). Age-related differences in lexical access, spreading activation, and simple pronunciation. *Psychology and Aging,* 3(1), 84-93.

Barrett, H. C., and Robert Kurzban. (2006). Modularity in Cognition: Framing the Debate. *Psychological Review,* 113, 628–647.

Bhatia, T. K. (1993). *Punjabi: A cognitive-descriptive grammar*. London: Routledge.

Cabo, D. P. Y., & Rothman, J. (2012). The (Il)Logical Problem of Heritage Speaker Bilingualism and Incomplete Acquisition. *Applied Linguistics,* 33(4), 450-455.

Caramazza, A., & Miozzo, M. (1997). The relation between syntactic and phonological knowledge in lexical access: Evidence from the 'tip-of-the-tongue' phenomenon. *Cognition,* 64(3), 309-343.

Chana, U., & Romaine, S. (1984). Evaluative reactions to Panjabi/English code-switching. *Journal of Multilingual and Multicultural Development,* 5(6), 447-473.

Chondrogianni, V., & Marinis, T. (2012). Production and processing asymmetries in the acquisition of tense morphology by sequential bilingual children. *Bilingualism: Language and Cognition,* 15(Special Issue 01), 5-21.

Clopper, C. G., & Pisoni, D. B. (2005). Perception of Dialect Variation. In D. B. Pisoni & R. E. Remez (Eds.), *The Handbook of Speech Perception*. Malden, Mass.; Oxford: Blackwell.

Colomé, À. (2001). Lexical Activation in Bilinguals' Speech Production: Language-Specific or Language-Independent? *Journal of Memory and Language,* 45(4), 721-736.

Colome, A., & Miozzo, M. (2010). Which Words Are Activated During Bilingual Word Production? *Journal of Experimental Psychology-Learning Memory and Cognition,* 36(1), 96-109.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: A Dual Route Cascaded Model of Visual Word Recognition and Reading Aloud. *Psychological Review,* 108(1), 204-256.

Costa, A., Caramazza, A., & Sebastian-Galles, N. (2000). The Cognate Facilitation Effect: Implications for Models of Lexical Access. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 26(5), 1283-1296.

Costa, A., La Heij, W., & Navarrete, E. (2006). The dynamics of bilingual lexical access. *Bilingualism: Language and Cognition,* 9(2), 137-151.

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual's two lexicons compete for selection? *Journal of Memory and Language,* 41(3), 365-397.

Daller, M. H., Yildiz, C., de Jong, N. H., Kan, S., & Basbagi, R. (2011). Language dominance in Turkish-German bilinguals: Methodological aspects of measurements in structurally different languages. *International Journal of Bilingualism,* 15(2), 215-236.

Dell, G. S. (1986). A Spreading-Activation Theory of Retrieval in Sentence Production. *Psychological Review,* 93(3), 283-321.

Dewaele, J.-M., & Wei, L. (2014). Attitudes towards code-switching among adult mono- and multilingual language users. *Journal of Multilingual and Multicultural Development,* 35(3), 235-251.

Dijkstra, T., & van Heuven, W. J. B. (2002). The architecture of the bilingual word recognition system: From identification to decision. *Bilingualism: Language and Cognition,* 5(03), 175-197.

Dunn, A. L., & Fox Tree, J. E. (2009). A quick, gradient Bilingual Dominance Scale. *Bilingualism: Language and Cognition,* 12(3), 273-289.

Ervin, S. M., & Osgood, C. E. (1954). Second language learning and bilingualism. *Journal of Abnormal Social Psychology, Supplement,* 49, 139-146.

Ethnologue (n.d.). Languages in India (online data). Retrieved 27.09.2008 from www.ethnologue.com

Fishman, J. A. (1965). Who Speaks What Language to Whom and When? *La Linguistique,* 1, 67-88.

Fishman, J. A. (1971). Domains and the relationship between micro- and macrosociolinguistics. In J. Gumperz & D. Hymes (Eds.), *Directions in Sociolinguistics. The ethnography of speaking.* New York: Holt, Rinehart and Winston.

Flege, J. E. (2002). Interactions between the native and second-language phonetic systems. In T. P. P. Burmeister & A. Rohde (Eds.), *An Integrated View of Language Development: Papers in Honor of Henning Wode* (pp. 217-224). Trier: Wissenschaftlicher Verlag.

Gardner-Chloros, P. (1991). *Language Selection and Switching in Strasbourg*. Oxford: Clarendon.

Gollan, T., Montoya, R., Fennema-Notestine, C., & Morris, S. (2005). Bilingualism affects picture naming but not picture classification. *Memory &Cognition,* 33(7), 1220-1234.

Goswami, K. (2002). *Punjabi-English Dictionary*. New York: Hippocrene Books

Green, D. W. (1986). Control, activation, and resource: A framework and a model for the control of speech in bilinguals. *Brain and Language,* 27(2), 210-223.

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition,* 1(02), 67-81.

Groot, A. M. B. d., & Kroll, J. F. (1997). *Tutorials in bilingualism: Psycholinguistic perspectives*. Mahwah, N.J.: Lawrence Erlbaum Associates.

Grosjean, F. (1982). *Life with Two Languages: An Introduction to Bilingualism.* Cambridge, Mass.: Harvard University Press.

Grosjean, F. (1998). Studying Bilinguals: Methodological and conceptual issues. *Bilingualism: Language and Cognition,* 1(02), 131-149.

Grosjean, F. (2008). *Studying Bilinguals.* Oxford: Oxford University Press.

Gumperz, J. J. (1982). *Discourse Strategies*. Cambridge: Cambridge University Press.

Hakuta, K., & Dandrea, D. (1992). Some Properties of Bilingual Maintenance and Loss in Mexican Background High-School Students. *Applied Linguistics,* 13(1), 72-99.

Hamers, J. F., & Blanc, M. (2000). *Bilinguality and Bilingualism* (2nd ed. ed.). Cambridge: Cambridge University Press.

Haugen, E. (1953). *The Norwegian Language in America*. Pennsylvania: University of Pennsylvania Press.

Hawkins, S. (2003). Roles and Representations of Systematic Fine Phonetic Detail in Speech Understanding. *Journal of Phonetics,* 31, 373–405.

Heller, M. (1988). *Codeswitching: Anthropological and Sociolinguistic Perspectives*. Berlin: Mouton de Gruyter.

Heller, M. (2003). *Crosswords: Language, education, and ethnicity in French Ontario*. Hawthorne, N.Y.: Mouton de Gruyter.

Hermans, D. (2004). Between-language identity effects in picture-word interference tasks: A challenge for language-nonspecific or language-specific models of lexical access? *International Journal of Bilingualism,* 8, 115-125.

Hermans, D., Bongaerts, T., De Bot, K., & Schreuder, R. (1998). Producing words in a foreign language: Can speakers prevent interference from their first language? *Bilingualism: Language and Cognition,* 1(03), 213-229.

Hirst, K. (1998). Preschool literacy experiences of children in Punjabi, Urdu and Gujarati speaking families in England. *British Educational Research Journal*, 24 (4), 415-429.

Hohenstein, J., Eisenberg, A., & Naigles, L. (2006). Is he floating across or crossing afloat? Cross-influence of L1 and L2 in Spanish-English bilingual adults. *Bilingualism: Language and Cognition,* 9(3), 249-261.

Hoshino, N., & Thierry, G. (2011). Language selection in bilingual word production: Electrophysiological evidence for cross-language competition. *Brain Research,* 1371, 100-109.

Ivanova, I., & Costa, A. (2008). Does bilingualism hamper lexical access in speech production. *Acta Psychologica,* 127(2), 277-288.

Joseph, S., Iverson, P., Manohar, S., Fox, Z., Scott, S. K., & Husain, M. (2015). Precision of Working Memory for Speech Sounds. *The Quarterly Journal of Experimental Psychology,* 68(10), 2022-2040

Katz, L., & Frost, R. (1992). Reading in different orthographies: the orthographic depth hypothesis. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning.* (pp. 67-84). Amsterdam: North-Holland.

Kaushanskaya, M., & Prior, A. (2015). Variability in the effects of bilingualism on cognition: It is not just about cognition, it is also about bilingualism. *Bilingualism: Language and Cognition,* 18(01), 27-28.

Kirkham, S. (2011). The Acoustics of Cononal Stops in British Asian English, *International Congress of Phonetic Sciences XVII* (pp. 1102-1105). Hing Kong.

Knupsky, A. C., & Amrhein, P. C. (2007). Phonological facilitation through translation in a bilingual picture-naming task. *Bilingualism: Language and Cognition,* 10(03), 211-223.

Kroll, J. F. (2015). On the consequences of bilingualism: We need language and the brain to understand cognition. *Bilingualism: Language and Cognition,* 18(1), 32-34.

Kroll, J. F., & Bialystok, E. (2013). Understanding the consequences of bilingualism for language processing and cognition. *Journal of Cognitive Psychology,* 25(5), 497-514.

Kroll, J. F., Bobb, S. C., Misra, M., & Guo, T. (2008). Language selection in bilingual speech: Evidence for inhibitory processes. *Acta Psychologica,* 128(3), 416-430.

Kroll, J. F., Bobb, S. C., & Wodniecka, Z. (2006). Language selectivity is the exception, not the rule: Arguments against a fixed locus of language selection in bilingual speech. *Bilingualism: Language and Cognition,* 9(02), 119-135.

Kroll, J. F., Dussias, P. E., Bogulski, C. A., & Valdes-Kroff, J. (2012). Juggling two languages in one mind: What bilinguals tell us about language processing and its consequences for cognition. In B. Ross (Ed.), *The Psychology of Learning and Motivation* (pp. 229-262 ). San Diego Academic Press.

Kroll, J. F., & Fricke, M. (2014). What bilinguals do with language that changes their minds and their brains. *Applied Psycholinguistics,* 35(5), 921-925.

Kroll, J. F., & Groot, A. M. B. d. (2005). *Handbook of Bilingualism: Psycholinguistic Approaches*. New York ; Oxford: Oxford University Press.

Labov, W. (1972). *Sociolinguistic Patterns*. Philadelphia: University of Philadelphia Press.

Ladefoged, P., & Maddieson, I. (1996). *The Sounds of the World's Languages*. Oxford, UK; Cambridge, Mass: Blackwell.

Lambert, K., Alam, F., & Stuart-Smith, J. (2007, 6-10 August 2007). *Investigating British Asian Accents: Studies from Glasgow.* Paper presented at the International Congress of Phonetic Sciences XVI, Saarbrücken.

Lambert, W. E. (1955). Measurement of the Linguistic Dominance in Bilinguals. *Journal of Abnormal and Social Psychology,* 50, 197-200.

Levelt, W. J. M. (1993). *Speaking: From Intention to Articulation*. Massachusetts: MIT Press.

Levelt, W. J. M. (1999). Models of word production. *Trends in Cognitive Sciences,* 3(6), 223-232.

Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (2000). A theory of lexical access in speech production. *Behavioral and Brain Sciences,* 22(01), 1-38.

Levinson, S. C. (1983). *Pragmatics*. Cambridge: Cambridge University Press.

Linck, J. A., Schwieter, J. W., & Sunderman, G. (2012). Inhibitory control predicts language switching performance in trilingual speech production. *Bilingualism: Language and Cognition* 15, 651-662.

Lorenzo-Seva, U. (2013). *How to report the percentage of explained common variance in exploratory factor analysis. Technical Report.* Department of Psychology, University of Tarragona.

Luk, G. (2015). Who are the bilinguals (and monolinguals)? *Bilingualism: Language and Cognition,* 18(01), 35-36.

Mackey, W. F. (1962). The description of bilingualism. *Canadian Journal of Linguistics,* 7, 51-85.

Marinis, T. (2010). Using on-line processig methods in language acquisition research. In S. Unsworth & E. Blom (Eds.), *Experimental Methods in Language Acquisition Research* (pp. 139-162): John Benjamins.

Marslen-Wilson, W., & Tyler, L. K. (1980). Temporal Structure of Spoken Language Understanding *Cognition,* 8(1), 1-71.

Meuter, R. F. I., & Allport, A. (1999). Bilingual language switching in naming: Asymmetrical costs of language selection. *Journal of Memory and Language,* 40(1), 25-40.

Meyer, A. S., & Belke, E. (2007). Word form retrieval in language production. In M. G. Gaskell & G. Altmann (Eds.), *The Oxford Handbook of Psycholinguistics.* Oxford: Oxford University Press.

Mobbs, M. (1985). *Britain's South Asian Languages*. London: Centre for Information on Language Teaching and Research.

Muysken, P. (2000). *Bilingual Speech: A typology of code-mixing*. Cambridge: Cambridge University Press.

Myers-Scotton, C. (1993). *Duelling languages: Grammatical structure in codeswitching*. Oxford: Clarendon Press.

Myers-Scotton, C. (1998). *Codes and Consequences: Choosing linguistic varieties*. New York; Oxford: Oxford University Press.

Myers-Scotton, C. (2000). Explaining the role of norms and rationality in codeswitching. *Journal of Pragmatics,* 32(9), 1259-1271.

Nettle, D., & Romaine, S. (2000). *Vanishing Voices: The Extinction of the World's Languages*. Oxford: Oxford University Press.

Norris, D., McQueen, J. M., & Cutler, A. (2000). Merging information in speech recognition: Feedback is never necessary. *Journal of Behavioral and Brain Sciences,* 23, 299-325.

O'Connor, J. D., & Arnold, G. F. (1961). *Intonation of Colloquial English.* London: Longman

ONS. (2005). Focus on Ethnicity and Identity Summary Report, March 2005 (online data).w Retrieved 23/09/2008 from www.ons.gov.uk/ons/rel/ethnicity/focus-on-ethnicity-and-identity/focus-on-ethnicity-and-identity-summary-report/index.html

Paradis, M. (2004). *A Neurolinguistic Theory of Bilingualism*. Amsterdam: John Benjamins Pub Co.

Pert, S., & Letts, C. (2006). Codeswitching in Mirpuri speaking Pakistani heritage preschool children: Bilingual language acquisition. *International Journal of Bilingualism,* 10(3), 349-374.

Pinker, S. (1994). *The Language Instinct: The new science of language and mind*. London: Allen Lane.

Pulvermüller, F. (2007). Brain Processes of Word Reading as Revealed by Neurophysiological Imaging. In Gareth Gaskell, M. (ed.), *Oxford Handbook of Psycholinguistics*. Oxford: Oxford University Press, pp. 119-140.

Rahman, T. (1996). *Language and Politics in Pakistan*. Karachi; Oxford: Oxford University Press.

Ratcliff, R. (1993). Methods for dealing with reaction-time outliers. *Psychological Bulletin,* 114(3), 510-532.

Roelofs, A. (1992). A spreading-activation theory of lemma retrieval in speaking. *Cognition,* 42(1-3), 107-142.

Roelofs, A., & Verhoef, K. (2006). Modeling the control of phonological encoding in bilingual speakers. *Bilingualism: Language and Cognition,* 9(2), 167-176.

Romaine, S. (1989). *Bilingualism*. Oxford: Blackwell.

Rothman, J., & Treffers-Daller, J. (2014). A Prolegomenon to the Construct of the Native Speaker: Heritage Speaker Bilinguals are Natives Too! *Applied Linguistics,* 35(1), 93-98.

Sawusch, J. R. (2005). Acoustic Analysis and Synthesis of Speech. In D. B. Pisoni & R. E. Remez (Eds.), *The Handbook of Speech Perception*). Malden, Mass.; Oxford: Blackwell.

Schriefers, H., Meyer, A. S., & Levelt, W. J. M. (1990). Exploring the time course of lexical access in language production: Picture-word interference studies. *Journal of Memory and Language,* 29(1), 86-102.

Scott, S. K., McGettigan, C., & Eisner, F. (2009). A little more conversation, a little less action - candidate roles for the motor cortex in speech perception. *Nat Rev Neurosci,* 10(4), 295-302.

Sebastian-Galles, N. (2005). Cross-Language Speech Perception. In D. B. Pisoni & R. E. Remez (Eds.), *The Handbook of Speech Perception*. Malden, Mass.; Oxford: Blackwell.

Sharma, D. (2011a). Cognitive and Social Forces in Dialect Shift: Gradual change in London Asian speech. *Language Variation and Change,* 23, 399–428.

Sharma, D. (2011b). Style repertoire and social change in British Asian English. *Journal of Sociolinguistics,* 15(4), 464-492.

Snodgrass, J. G., & Vanderwart, M. (1980). Standardized set of 260 pictures - norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology-Human Learning and Memory,* 6(2), 174-215.

Spalek, K., Hoshino, N., Wu, Y. J., Damian, M., & Thierry, G. (2014). Speaking two languages at once: Unconscious native word form access in second language production. *Cognition,* 133(1), 226-231.

Stevens, K. N. (2005). Features in Speech Perception and Lexical Access. In D. B. Pisoni & R. E. Remez (Eds.), *The Handbook of Speech Perception*. Malden, Mass.; Oxford: Blackwell.

Stuart-Smith, J., & Martin, D. (1998). Exploring bilingual children's perceptions of being bilingual and biliterate: Implications for educational provision. *British Journal of Sociology of Education,* 19(2), 237-254.

Stuart-Smith, J. (1997). Uncertainty in the community language classroom: A response to Michael Clyne. *Current Issues in Language and Society*, 4 (2), 159-161.

Stuart-Smith, J., & Martin, D. (1999). Developing assessment procedures for phonological awareness for use with Panjabi-English bilingual children. *International Journal of Bilingualism*, 3 (1), 55-80.

Toribio, A. J. (2001). On the emergence of bilingual code-switching competence. *Bilingualism: Language and Cognition,* 4, 203-231.

Treffers-Daller, J. (1997). Variability in code-switching styles: Turkish-German code-switching patterns. . In R. Jacobson (Ed.), *Codeswitching Worldwide* (pp. 177-197). Berlin: Mouton de Gruyter.

Treffers-Daller, J. (2011). Operationalizing and measuring language dominance. *International Journal of Bilingualism,* 15, 147-163.

Treffers-Daller, J. (2015). The construct of language dominance, its operationalization and measurement. In: Silva-Corvalan, C. and Treffers-Daller, J. (eds.) Language Dominance in Bilinguals: Issues of Measurement and Operationalization. Cambridge University Press, Cambridge, pp. 235-265. ISBN 9781107044494

Weinreich, U. (1953). *Languages in Contact*. The Hague: Mouton.

Wheeldon, L. R., & Levelt, W. J. M. (1995). Monitoring the Time-Course of Phonological Encoding. *Journal of Memory and Language,* 34(3), 311-334.

Wolfson, N. (1976). Speech events and natural speech: some implications for sociolinguistic methodology. *Language in Society* 5(2), 189-209.

Wu, Y. J., Cristino, F., Leek, C., & Thierry, G. (2013). Non-selective lexical access in bilinguals is spontaneous and independent of input monitoring: Evidence from eye tracking. *Cognition,* 129(2), 418-425.

Wu, Y. J., & Thierry, G. (2010). Investigating bilingual processing: the neglected role of language processing contexts. *Frontiers in Psychology,* 1.

Wu, Y. J., & Thierry, G. (2011). Event-related brain potential investigation of preparation for speech production in late bilinguals. *Frontiers in Psychology,* 2.

Wu, Y. J., & Thierry, G. (2012). Unconscious translation during incidental foreign language processing. *Neuroimage,* 59(4), 3468-3473.

Wu, Y. J., & Thierry, G. (2013). Fast Modulation of Executive Function by Language Context in Bilinguals. *Journal of Neuroscience,* 33(33), 13533.

# Appendix 1: Participant Information Sheet / Consent Form

**INFORMATION SHEET FOR PARTICIPANTS**

*REC Protocol Number:* **REP(EM)/08/09-22**

**YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET**

KING'S College LONDON
University of London

## The Role of Phonology in Bilingualism

*I would like to invite you to participate in this postgraduate research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please read the following information carefully and discuss it with others if you wish. Please ask me if there is anything that is not clear or if you would like more information.*

This study explores whether a bilingual person calls on knowledge of ***both*** of their languages even while using only ***one*** of them.

If you choose to participate, you will sit at a laptop with headphones on looking at pictures of everyday objects and will answer simple yes/no questions about the name of the picture. At the end of the task you will name each of the pictures in your own words. I will also ask you to complete an email questionnaire about the languages that you know and how you used them in your childhood and now. A smaller number of participants may be asked if they are willing to talk more about their language use in an informal recorded interview. It would be preferable if you participated in both the questionnaire and the interview, but this is not a requirement.

To participate in the study you need to be over 18 and to have been speaking Punjabi regularly since infancy and English for five years or more. ***You do not need to be able to write in Punjabi or speak it perfectly.*** The experiment session will take about 35 minutes and the email questionnaire will take you 10-15 minutes to complete.

The information that you share with me in your questionnaire and interview and the results of the experiment will be confidential. Interview recordings and anonymised questionnaires, transcripts and experiment data will be stored securely and you will not be identifiable from quotation or reporting. It will not be possible to identify you from any publications.

Please be aware that you can withdraw from the study at any point. If you decide to withdraw during an experiment or an interview, please simply ask me to stop the recorder or the experiment. If you have already participated and on reflection prefer not to take part, please let me know within one month and I will destroy your data. If you decide to participate I will provide you with a printed copy of this information sheet and one consent form to sign when we meet for the experiment with another form for the interview. Sending me a completed questionnaire beforehand will be taken as consent for the questionnaire element of the study.

**About the Researcher**
Joanna John, c/o Gabriella Rundblad, Centre for Language, Discourse and Communication, Department of Education and Professional Studies, Kings College London, Franklin-Wilkins Building, Waterloo Bridge Wing, Waterloo Road, London SE1 9NH. If you wish to receive a copy of the research report please email at joanna.john@kcl.ac.uk or call me on 0118 378 4452.
It is up to you to decide whether to take part or not. If you decide to take part you are still free to withdraw at any time and without giving a reason. If this study has harmed you in any way you can contact King's College London for further advice and information: Dr Gabriella Rundblad, Lecturer in Applied Linguistics, Department of Educational and Professional Studies email gabriella.rundblad@kcl.ac.uk.

**CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES**

KING'S College LONDON
University of London

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: The Role of Phonology in Bilingualism

King's College Research Ethics Committee Ref: REP(EM)/08/09-22

- I agree that the research project named above has been explained to me to my satisfaction and agree to take part in the study. I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be treated in accordance with the terms of the Data Protection Act 1998.
- *I understand that if I decide at any time during the research that I no longer wish to participate in this project, I can notify the researchers involved and withdraw from it immediately without giving any reason. Furthermore, I understand that I will be able to withdraw my data within one month of participating.*

Participant's Statement:

I _____ agree that the research project named above has been explained to me to my satisfaction and I agree to take part in the study. I have read both the notes written above and the Information Sheet about the project, and understand what the research study involves.

# Appendix 2: Survey of Language Use

## Language Questionnaire for British Asian English-Punjabi Bilinguals

This questionnaire asks about the languages you know, the way you were introduced and exposed to them in childhood and how you use them now. It accompanies the bilingual processing task for the study *The Role of Phonology in Bilingualism* (http://www.kcl.ac.uk/projects/ldc/jjohn). If you want to know more about why any of the questions is relevant, please email me (joanna.john@kcl.ac.uk) to ask.

### A. About You

**Year of Birth:** _____ **Age:** _____ **Sex:** _____ **Country of birth:** _____

**Have you ever lived in any countries other than the UK?** Yes ☐ No ☐ If yes, please indicate countries below.
Country: _____ Number of years I lived there: _____ Age at time: _____

**Were your parents born in the UK?** (*delete*) One of them / Neither / Both
**Was all of your primary and secondary education in the UK?** (*delete*) Yes/ No
**Handedness:** (*delete*) Left-handed / Right-handed

**Faith:** (*delete*) Prefer not to say / No Faith / Buddhism / Hinduism / Islam / Jainism / Sikhism / Other faith

**Which is the highest level of qualification you have?** (*delete*)
School leaving qualification / A Level or equivalent / Bachelors Degree or equivalent / Postgraduate

**When you were a child, were there siblings/other children living in your home?** Yes ☐ No ☐
**Do you consider yourself to have any of the following: visual/hearing impairments, learning disability?** Yes ☐ No ☐

### B. Language in Your Childhood

**1. Which languages did you know by the age of 4?**

| Name of language | Speak (tick) | Understand (tick) | Were these languages introduced in any order? |
|---|---|---|---|
| _____ | ☐ | ☐ | This was the 1st language ☐ This was the 2nd language ☐ This was the 3rd language ☐ Both at same time ☐ I can't remember ☐ |
| _____ | ☐ | ☐ | This was the 1st language ☐ This was the 2nd language ☐ This was the 3rd language ☐ Both at same time ☐ I can't remember ☐ |
| _____ | ☐ | ☐ | This was the 1st language ☐ This was the 2nd language ☐ This was the 3rd language ☐ Both at same time ☐ I can't remember ☐ |

**2. If you speak another South Asian language (e.g. Urdu, Hindi) as well as Punjabi, which one do you use more often?**
(*delete*) I use Punjabi more often / I use the other language more often / Both equally / I don't speak another South Asian language

**3. If you were bilingual on your first day of school, was one of your languages noticeably stronger than the other?**
Yes ☐ No ☐ Not Sure ☐ Stronger language (if applicable: _____

**4. How would you describe your knowledge of English on your first day of school?**

| | | | | |
|---|---|---|---|---|
| **Understanding:** | None ☐ | Very little ☐ | Quite a bit ☐ | A lot ☐ |
| **Speaking:** | None ☐ | Very little ☐ | Quite a bit ☐ | A lot ☐ |

**5. How would you describe your knowledge of Punjabi on your first day of school?**

| | | | | |
|---|---|---|---|---|
| **Understanding:** | None ☐ | Very little ☐ | Quite a bit ☐ | A lot ☐ |
| **Speaking:** | None ☐ | Very little ☐ | Quite a bit ☐ | A lot ☐ |

**6. Which other languages (if any) did you know by the age of 12?**

| Name of language | Speak (tick) | Understand (tick) | Approximate age it was introduced to you, if known |
|---|---|---|---|
| _____ | ☐ | ☐ | _____ |
| _____ | ☐ | ☐ | _____ |

**7. Literacy.** In which languages can you read? _____

For researcher's use only. Participant number: _____

Show next page (Right Arrow)

8. **Age 5-16, which language did these people speak to you in?**

| | Not Applicable | They speak (tick): Only English | Mainly English, some Punjabi | Both Equally | Mainly Punjabi, some English | Only Punjabi | I answer (tick): Only English | Mainly English, some Punjabi | Both Equally | Mainly Punjabi, some English | Only Punjabi | *If you speak another South Asian language, do you ever use it with this person? (delete)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **With my mother** | | | | | | | | | | | | Yes / No |
| **With my father** | | | | | | | | | | | | Yes / No |
| **With siblings** | | | | | | | | | | | | Yes / No |
| **With my elder relatives** | | | | | | | | | | | | Yes / No |
| **With my closest friends** | | | | | | | | | | | | Yes / No |
| **With my other friends** | | | | | | | | | | | | Yes / No |

## C. Language in Your Life Now

1. **Age 16+ did you become fluent in any other language?**
   Yes ☐ No ☐ Language: _____ If yes, are you using this language regularly? Yes ☐ No ☐

2. **At the current time, do you feel one of your languages is stronger than the other?**
   Yes ☐ No ☐ Stronger language, if applicable: _____

3. **In your current life, in which language do these people speak to you?**

| | Not Applicable | They speak (tick): Only English | Mainly English, some Punjabi | Both Equally | Mainly Punjabi, some English | Only Punjabi | I answer (tick): Only English | Mainly English, some Punjabi | Both Equally | Mainly Punjabi, some English | Only Punjabi | *If you speak another South Asian language, do you ever use another language with this person? (delete)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **With my partner** | | | | | | | | | | | | Yes / No |
| **With my children** | | | | | | | | | | | | Yes / No |
| **With my mother** | | | | | | | | | | | | Yes / No |
| **With my father** | | | | | | | | | | | | Yes / No |
| **With siblings** | | | | | | | | | | | | Yes / No |
| **With my elder relatives** | | | | | | | | | | | | Yes / No |
| **With my closest friends** | | | | | | | | | | | | Yes / No |
| **With my other friends** | | | | | | | | | | | | Yes / No |
| **With my colleagues** | | | | | | | | | | | | Yes / No |
| **With my neighbours** | | | | | | | | | | | | Yes / No |

4. **When speaking with other English-Punjabi bilinguals, is one of your languages more likely to be used for certain topics?**

| (Tick) | *Not Applicable (I don't do this)* | Yes, English | Yes, Punjabi | I can't tell |
|---|---|---|---|---|
| **Talking about work** | | | | |
| **Domestic or family talk** | | | | |
| **Prayer or religious discussion** | | | | |
| **Gossiping** | | | | |
| **Discussing news or politics** | | | | |

For researcher's use only. Participant number: _____

5. **How often do you hear and speak each language?**

| *(Tick)* | Every Day | 4-5 times a week | 2-3 times a week | Once a week | 2-3 times a month | Once a month |
|---|---|---|---|---|---|---|
| **Hear Punjabi spoken** | | | | | | |
| **Hear English spoken** | | | | | | |
| **Speak Punjabi yourself** | | | | | | |
| **Speak English yourself** | | | | | | |
| **Use both languages within the same day** | | | | | | |
| **Change between languages – within the same conversation** | | | | | | |
| **Change between languages – within the same sentence** | | | | | | |

## D. Final Word

1. **Any other comments on the regional origin of your Punjabi (e.g. India/Pakistan/Kenya) or its variety. (Optional.)**
   _____
2. **In your own words…. (Optional.)** Do you want to add any other comment about your languages or their importance to you?
   _____

**About the Researcher:** Joanna John, c/o Gabriella Rundblad, Centre for Language, Discourse and Communication, Department of Education and Professional Studies, Kings College London, Franklin-Wilkins Building, Waterloo Bridge Wing, Waterloo Road, London SE1 9NH. If you wish to receive a copy of the research report please email at joanna.john@kcl.ac.uk. It is up to you to decide whether to take part or not. You are free to withdraw at any time and without giving a reason. If this study has harmed you in any way you can contact King's College London for further advice and information: Dr Gabriella Rundblad, Lecturer in Applied Linguistics, Department of Educational and Professional Studies email gabriella.rundblad@kcl.ac.uk.

For researcher's use only. Participant number: _____

## Appendix 3: Order of Stimuli in Each List

(1) The 'Trial Name' column indicates the combination of picture, phoneme and correct response contained in each individual trial.
(2) In the Related Condition the picture was presented with a phoneme which formed the onset of its Punjabi name and which did not feature its English name. In the Unrelated Condition the picture was presented with a phoneme featuring in neither its English name nor its Punjabi name. English 1 and English 2 conditions did not form part of the analysis and served to balance positive and negative responses.

| Order A | | | Order B | | | Order C | | | Order D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* |
| 1 | Fist-w-NO | Unrelated | 1 | Spoon-ch-NO | Related | 1 | Watch-w-YES | English 1 | 1 | Window-t-NO | Unrelated |
| 2 | Shirt-t-YES | English 2 | 2 | Flower-p-NO | Related | 2 | Cat-b-NO | Related | 2 | Flower-p-NO | Related |
| 3 | Flower-w-YES | English 2 | 3 | Window-w-YES | English 1 | 3 | Flower-f-YES | English 1 | 3 | Candle-k-YES | English 1 |
| 4 | Fish-v-NO | Unrelated | 4 | Bone-n-YES | English 2 | 4 | Needle-s-NO | Related | 4 | Bird-n-NO | Unrelated |
| 5 | Fly-f-YES | English 1 | 5 | Flower-d-NO | Unrelated | 5 | Window-b-NO | Related | 5 | Fly-v-NO | Unrelated |
| 6 | Monkey-b-NO | Related | 6 | Monkey-m-YES | English 1 | 6 | Spoon-n-YES | English 2 | 6 | Pillow-l-YES | English 2 |
| 7 | Watch-ch-YES | English 2 | 7 | Pillow-v-NO | Unrelated | 7 | Fish-f-YES | English 1 | 7 | Spoon-d-NO | Unrelated |
| 8 | Curtain-p-NO | Related | 8 | Bird-ch-NO | Related | 8 | Candle-w-NO | Unrelated | 8 | Monkey-k-YES | English 2 |
| 9 | Spoon-s-YES | English 1 | 9 | Foot-ga-NO | Unrelated | 9 | Pillow-s-NO | Related | 9 | Needle-v-NO | Unrelated |
| 10 | Fly-l-YES | English 2 | 10 | Well-w-YES | English 1 | 10 | Bird-d-YES | English 2 | 10 | Cat-v-NO | Unrelated |
| 11 | Well-k-NO | Related | 11 | Fish-sh-YES | English 2 | 11 | Curtain-k-YES | English 1 | 11 | Foot-p-NO | Related |
| 12 | Shirt-sh-YES | English 1 | 12 | Bone-h-NO | Related | 12 | Watch-ch-YES | English 2 | 12 | Fist-t-YES | English 2 |
| 13 | Candle-d-YES | English 2 | 13 | Cat-k-YES | English 1 | 13 | Well-t-NO | Unrelated | 13 | Bone-h-NO | Related |
| 14 | Curtain-sh-NO | Unrelated | 14 | Cat-t-YES | English 2 | 14 | Fish-m-NO | Related | 14 | Curtain-t-YES | English 2 |
| 15 | Foot-t-YES | English 2 | 15 | Fist-m-NO | Related | 15 | Shirt-n-NO | Related | 15 | Heart-t-YES | English 2 |
| 16 | Shirt-n-NO | Unrelated | 16 | Curtain-p-NO | Related | 16 | Fly-l-YES | English 2 | 16 | Shirt-k-NO | Related |
| 17 | Bird-b-YES | English 1 | 17 | Watch-l-NO | Unrelated | 17 | Heart-w-NO | Unrelated | 17 | Well-l-YES | English 2 |
| 18 | Fist-f-YES | English 1 | 18 | Shirt-sh-YES | English 1 | 18 | Fist-f-YES | English 1 | 18 | Watch-g-NO | Related |
| 19 | Bone-l-NO | Unrelated | 19 | Bird-d-YES | English 2 | 19 | Curtain-t-YES | English 2 | 19 | Knife-w-NO | Unrelated |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | Needle-d-YES | English 2 | 20 | Candle-m-NO | Related | 20 | Bone-b-YES | Engish 1 | 20 | Fish-m-NO | Related |
| 21 | Curtain-k-YES | English 1 | 21 | Knife-n-YES | English 1 | 21 | Cat-v-NO | Unrelated | 21 | Bone-n-YES | English 2 |
| 22 | Foot-p-NO | Related | 22 | Window-t-NO | Unrelated | 22 | Flower-w-YES | English 2 | 22 | Foot-g-NO | Unrelated |
| 23 | Cat—t-YES | English 2 | 23 | Fly-m-NO | Related | 23 | Fist-w-NO | Unrelated | 23 | Pillow-s-NO | Related |
| 24 | Pillow-p-YES | English 1 | 24 | Needle-n-YES | English 1 | 24 | Bone-l-NO | Unrelated | 24 | Watch-w-YES | English 1 |
| 25 | Well-l-YES | English 2 | 25 | Flower-p-NO | Related | 25 | Fly-f-YES | English 1 | 25 | Knife-n-YES | English 1 |
| 26 | Needle-v-NO | Unrelated | 26 | Knife-f-YES | English 2 | 26 | Heart-t-YES | English 2 | 26 | Well-k-NO | Related |
| 27 | Fist-m-NO | Related | 27 | Foot-f-YES | English 1 | 27 | Foot-f-YES | English 1 | 27 | Window-d-YES | English 2 |
| 28 | Knife-f-YES | English 2 | 28 | Knife-w-NO | Unrelated | 28 | Knife-ch-NO | Related | 28 | Heart-h-YES | English 1 |
| 29 | Cat-B-NO | Related | 29 | Window-b-NO | Related | 29 | Monkey-f-NO | Unrelated | 29 | Flower-f-YES | English 1 |
| 30 | Window-d-YES | Unrelated | 30 | Curtain-sh-NO | Unrelated | 30 | Foot-t-YES | English 2 | 30 | Fly-m-NO | Related |
| 31 | Flower-d-NO | Unrelated | 31 | Heart-h-YES | English 1 | 31 | Shirt-k-NO | Related | 31 | Shirt-n-NO | Unrelated |
| 32 | Fish-sh-YES | English 2 | 32 | Monkey-b-NO | Related | 32 | Fist-t-YES | English 2 | 32 | Curtain-p-NO | Related |
| 33 | Heart-d-NO | Related | 33 | Fist-t-YES | English 2 | 33 | Foot-g-NO | Unrelated | 33 | Spoon-s-YES | English 1 |
| 34 | Cat-k-YES | English 1 | 34 | Heart-d-NO | Related | 34 | Cat-t-YES | English 2 | 34 | Fist-m-NO | Related |
| 35 | Fly-v-NO | Unrelated | 35 | Pillow-p-YES | English 1 | 35 | Knife-w-NO | Unrelated | 35 | Needle-s-NO | Related |
| 36 | Knife-ch-NO | Related | 36 | Shirt-t-YES | English 2 | 36 | Flower-p-NO | Related | 36 | Cat-k-YES | English 1 |
| 37 | Monkey-k-YES | English 2 | 37 | Candle-D-YES | English 2 | 37 | Window-w-YES | English 1 | 37 | Bird-ch-NO | Related |
| 38 | Heart-w-NO | Unrelated | 38 | Foot-p-NO | Related | 38 | Monkey-m-YES | English 1 | 38 | Monkey-f-NO | Unrelated |
| 39 | Needle-s-NO | Related | 39 | Well-t-NO | Unrelated | 39 | Watch-g-NO | Related | 39 | Candle-w-NO | Unrelated |
| 40 | Bird-n-NO | Unrelated | 40 | Knife-ch-NO | Related | 40 | Spoon-ch-NO | Related | 40 | Well-w-YES | English 1 |
| 41 | Candle-k-YES | English 1 | 41 | Heart-t-YES | English 2 | 41 | Monkey-b-NO | Related | 41 | Pillow-v-NO | Unrelated |
| 42 | Cat-v-NO | Unrelated | 42 | Fist-w-NO | Unrelated | 42 | Window-d-YES | English 2 | 42 | Fish-v-NO | Unrelated |
| 43 | Heart-h-YES | English 1 | 43 | Spoon-n-YES | English 2 | 43 | Needle-n-YES | English 1 | 43 | Fish-sh-YES | English 2 |
| 44 | Needle-n-YES | English 1 | 44 | Needle-d-YES | English 2 | 44 | Knife-f-YES | English 2 | 44 | Knife-ch-NO | Related |
| 45 | Window-b-NO | Related | 45 | Watch-g-NO | Related | 45 | Fly-v-NO | Unrelated | 45 | Bird-d-YES | English 2 |
| 46 | Fly-m-NO | Related | 46 | Fish-f-YES | English 1 | 46 | Heart-d-NO | Related | 46 | Cat-B-NO | Related |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | Flower-f-YES | Engish 1 | 47 | Bird-b-YES | English 1 | 47 | Pillow-v-NO | Unrelated | 47 | Flower-d-NO | Unrelated |
| 48 | Watch-l-NO | Unrelated | 48 | Monkey-k-YES | English 2 | 48 | Monkey-k-YES | English 2 | 48 | Foot-t-YES | English 2 |
| 49 | Window-t-NO | Unrelated | 49 | Needle-v-NO | Unrelated | 49 | Window-t-NO | Unrelated | 49 | Heart-w-NO | Unrelated |
| 50 | Bone-b-YES | English 1 | 50 | Fly-l-YES | English 2 | 50 | Bird-b-YES | English 1 | 50 | Window-w-YES | English 1 |
| 51 | Pillow-l-YES | English 2 | 51 | Window-d-YES | English 2 | 51 | Pillow-p-YES | English 1 | 51 | Shirt-sh-YES | English 1 |
| 52 | Candle-w-NO | Unrelated | 52 | Bird-n-NO | Unrelated | 52 | Spoon-d-NO | Unrelated | 52 | Fly-l-YES | English 2 |
| 53 | Window-w-YES | English 1 | 53 | Pillow-l-YES | English 2 | 53 | Fist-m-NO | Related | 53 | Spoon-ch-YES | Related |
| 54 | Flower-p-NO | Related | 54 | Heart-w-NO | Unrelated | 54 | Well-w-YES | English 1 | 54 | Watch-l-NO | Unrelated |
| 55 | Monkey-f-NO | Unrelated | 55 | Well-k-NO | Related | 55 | Fish-v-NO | Unrelated | 55 | Monkey-m-YES | English 1 |
| 56 | Bird-ch-NO | Related | 56 | Spoon-s-YES | English 1 | 56 | Fish-sh-YES | English 2 | 56 | Needle-n-YES | English 1 |
| 57 | Watch-w-YES | English 1 | 57 | Shirt-k-NO | Related | 57 | Bird-n-NO | Unrelated | 57 | Candle-m-NO | Related |
| 58 | Bone-h-NO | Related | 58 | Monkey-f-NO | Unrelated | 58 | Candle-m-NO | Related | 58 | Fist-f-YES | English 1 |
| 59 | Fist-t-YES | English 2 | 59 | Well-l-YES | English 2 | 59 | Fly-m-NO | Related | 59 | Curtain-sh-NO | Unrelated |
| 60 | Candle-m-NO | Related | 60 | Watch-ch-YES | English 2 | 60 | Bone-n-YES | English 2 | 60 | Bone-b-YES | English 1 |
| 61 | Bone-n-YES | English 2 | 61 | Bone-l-NO | Unrelated | 61 | Needle-d-YES | English 2 | 61 | Needle-d-YES | English 2 |
| 62 | Watch-g-NO | Related | 62 | Candle-k-YES | English 1 | 62 | Well-l-YES | English 2 | 62 | Pillow-p-YES | English 1 |
| 63 | Spoon-ch-YES | Related | 63 | Fish-m-NO | Related | 63 | Curtain-p-NO | Related | 63 | Well-t-NO | Unrelated |
| 64 | Fish-f-YES | English 1 | 64 | Flower-w-YES | English 2 | 64 | Shirt-t-YES | English 2 | 64 | Shirt-t-YES | English 2 |
| 65 | Foot-f-YES | English 1 | 65 | Needle-s-NO | Related | 65 | Shirt-sh-YES | English 1 | 65 | Spoon-n-YES | English 2 |
| 66 | Pillow-s-NO | Related | 66 | Shirt-n-NO | Unrelated | 66 | Spoon-s-YES | English 1 | 66 | Watch-ch-YES | English 2 |
| 67 | Well-t-NO | Unrelated | 67 | Pillow-s-NO | Related | 67 | Curtain-sh-NO | Unrelated | 67 | Window-b-NO | Related |
| 68 | Monkey-m-YES | English 1 | 68 | Watch-w-YES | English 1 | 68 | Bone-h-NO | Related | 68 | Heart-d-NO | Related |
| 69 | Knife-n-YES | English 1 | 69 | Cat-v-NO | Unrelated | 69 | Knife-n-YES | English 1 | 69 | Curtain-k-YES | English 1 |
| 70 | Spoon-d-NO | Unrelated | 70 | Bone-b-YES | English 1 | 70 | Needle-v-NO | Unrelated | 70 | Fish-f-YES | English 1 |
| 71 | Bird-d-YES | English 2 | 71 | Curtain-k-YES | English 1 | 71 | Cat-k-YES | English 1 | 71 | Monkey-b-NO | Related |
| 72 | Fish-m-NO | Related | 72 | Candle-w-NO | Unrelated | 72 | Foot-p-NO | Related | 72 | Flower-w-YES | English 2 |
| 73 | Curtain-t-YES | English 2 | 73 | Fist-f-YES | English 1 | 73 | Candle-d-YES | English 2 | 73 | Bird-b-YES | English 1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 74 | Pillow-v-NO | Unrelated | 74 | Flower-f-YES | Unrelated | 74 | Bird-ch-NO | Related | 74 | Knife-f-YES | English 2 |
| 75 | Spoon-n-YES | English 2 | 75 | Spoon-d-NO | Unrelated | 75 | Pillow-l-YES | English 2 | 75 | Bone-l-NO | Unrelated |
| 76 | Shirt-k-NO | Related | 76 | Foot-t-YES | English 2 | 76 | Flower-d-NO | Unrelated | 76 | Foot-f-YES | English 1 |
| 77 | Knife-w-NO | Unrelated | 77 | Curtain-t-YES | English 2 | 77 | Well-k-NO | Related | 77 | Candle-d-YES | English 2 |
| 78 | Heart-t-YES | English 2 | 78 | Fly-v-NO | Unrelated | 78 | Watch-l-NO | Unrelated | 78 | Fist-w-NO | Unrelated |
| 9 | Well-w-YES | English 1 | 79 | Fish-v-NO | Unrelated | 79 | Heart-h-YES | English 1 | 79 | Fly-f-YES | Engish 1 |
| 80 | Foot-g-NO | Related | 80 | Cat-b-NO | Related | 80 | Candle-k-YES | English1 | 80 | Cat—t-YES | English 2 |

**Order of Stimuli by Trial Name**

| Order A | | | Order B | | | Order C | | | Order D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* |
| 17 | Bird-b-YES | English 1 | 47 | Bird-b-YES | English 1 | 50 | Bird-b-YES | English 1 | 73 | Bird-b-YES | English 1 |
| 56 | Bird-ch-NO | Related | 8 | Bird-ch-NO | Related | 74 | Bird-ch-NO | Related | 37 | Bird-ch-NO | Related |
| 71 | Bird-d-YES | English 2 | 19 | Bird-d-YES | English 2 | 10 | Bird-d-YES | English 2 | 45 | Bird-d-YES | English 2 |
| 40 | Bird-n-NO | Unrelated | 52 | Bird-n-NO | Unrelated | 57 | Bird-n-NO | Unrelated | 4 | Bird-n-NO | Unrelated |
| 50 | Bone-b-YES | English 1 | 70 | Bone-b-YES | English 1 | 20 | Bone-b-YES | English 1 | 60 | Bone-b-YES | English 1 |
| 58 | Bone-h-NO | Related | 12 | Bone-h-NO | Related | 68 | Bone-h-NO | Related | 13 | Bone-h-NO | Related |
| 19 | Bone-l-NO | Unrelated | 61 | Bone-l-NO | Unrelated | 24 | Bone-l-NO | Unrelated | 75 | Bone-l-NO | Unrelated |
| 61 | Bone-n-YES | English 2 | 4 | Bone-n-YES | English 2 | 60 | Bone-n-YES | English 2 | 21 | Bone-n-YES | English 2 |
| 13 | Candle-d-YES | English 2 | 37 | Candle-D-YES | English 2 | 73 | Candle-d-YES | English 2 | 77 | Candle-d-YES | English 2 |
| 41 | Candle-k-YES | English 1 | 62 | Candle-k-YES | English 1 | 80 | Candle-k-YES | English1 | 3 | Candle-k-YES | English 1 |
| 60 | Candle-m-NO | Related | 20 | Candle-m-NO | Related | 58 | Candle-m-NO | Related | 57 | Candle-m-NO | Related |
| 52 | Candle-w-NO | Unrelated | 72 | Candle-w-NO | Unrelated | 8 | Candle-w-NO | Unrelated | 39 | Candle-w-NO | Unrelated |
| 29 | Cat-B-NO | Related | 80 | Cat-b-NO | Related | 2 | Cat-b-NO | Related | 46 | Cat-B-NO | Related |
| 34 | Cat-k-YES | English 1 | 13 | Cat-k-YES | English 1 | 71 | Cat-k-YES | English 1 | 36 | Cat-k-YES | English 1 |
| 23 | Cat—t-YES | English 2 | 14 | Cat-t-YES | English 2 | 34 | Cat-t-YES | English 2 | 80 | Cat—t-YES | English 2 |
| 42 | Cat-v-NO | Unrelated | 69 | Cat-v-NO | Unrelated | 21 | Cat-v-NO | Unrelated | 10 | Cat-v-NO | Unrelated |
| 21 | Curtain-k-YES | English 1 | 71 | Curtain-k-YES | English 1 | 11 | Curtain-k-YES | English 1 | 69 | Curtain-k-YES | English 1 |
| 8 | Curtain-p-NO | Related | 16 | Curtain-p-NO | Related | 63 | Curtain-p-NO | Related | 32 | Curtain-p-NO | Related |
| 14 | Curtain-sh-NO | Unrelated | 30 | Curtain-sh-NO | Unrelated | 67 | Curtain-sh-NO | Unrelated | 59 | Curtain-sh-NO | Unrelated |
| 73 | Curtain-t-YES | English 2 | 77 | Curtain-t-YES | English 2 | 19 | Curtain-t-YES | English 2 | 14 | Curtain-t-YES | English 2 |
| 64 | Fish-f-YES | English 1 | 46 | Fish-f-YES | English 1 | 7 | Fish-f-YES | English 1 | 70 | Fish-f-YES | English 1 |
| 72 | Fish-m-NO | Related | 63 | Fish-m-NO | Related | 14 | Fish-m-NO | Related | 20 | Fish-m-NO | Related |
| 32 | Fish-sh-YES | English 2 | 11 | Fish-sh-YES | English 2 | 56 | Fish-sh-YES | English 2 | 43 | Fish-sh-YES | English 2 |

| 4 | Fish-v-NO | Unrelated | 79 | Fish-v-NO | Unrelated | 55 | Fish-v-NO | Unrelated | 42 | Fish-v-NO | Unrelated |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Order A | | | Order B | | | Order C | | | Order D | | |
| *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial name* | *Condition* | *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* |
| 18 | Fist-f-YES | English 1 | 73 | Fist-f-YES | English 1 | 18 | Fist-f-YES | English 1 | 58 | Fist-f-YES | English 1 |
| 27 | Fist-m-NO | Related | 15 | Fist-m-NO | Related | 53 | Fist-m-NO | Related | 34 | Fist-m-NO | Related |
| 59 | Fist-t-YES | English 2 | 33 | Fist-t-YES | English 2 | 32 | Fist-t-YES | English 2 | 12 | Fist-t-YES | English 2 |
| 1 | Fist-w-NO | Unrelated | 42 | Fist-w-NO | Unrelated | 23 | Fist-w-NO | Unrelated | 78 | Fist-w-NO | Unrelated |
| 31 | Flower-d-NO | Unrelated | 5 | Flower-d-NO | Unrelated | 76 | Flower-d-NO | Unrelated | 47 | Flower-d-NO | Unrelated |
| 47 | Flower-f-YES | English 1 | 74 | Flower-f-YES | Unrelated | 3 | Flower-f-YES | English 1 | 29 | Flower-f-YES | English 1 |
| 54 | Flower-p-NO | Related | 2 | Flower-p-NO | Related | 36 | Flower-p-NO | Related | 2 | Flower-p-NO | Related |
| 3 | Flower-w-YES | English 2 | 25 | Flower-p-NO | Related | 22 | Flower-w-YES | English 2 | 72 | Flower-w-YES | English 2 |
| 5 | Fly-f-YES | English 1 | 64 | Flower-w-YES | English 2 | 25 | Fly-f-YES | English 1 | 79 | Fly-f-YES | English 1 |
| 10 | Fly-l-YES | English 2 | 50 | Fly-l-YES | English 2 | 16 | Fly-l-YES | English 2 | 52 | Fly-l-YES | English 2 |
| 46 | Fly-m-NO | Related | 23 | Fly-m-NO | Related | 59 | Fly-m-NO | Related | 30 | Fly-m-NO | Related |
| 35 | Fly-v-NO | Unrelated | 78 | Fly-v-NO | Unrelated | 45 | Fly-v-NO | Unrelated | 5 | Fly-v-NO | Unrelated |
| 65 | Foot-f-YES | English 1 | 27 | Foot-f-YES | English 1 | 27 | Foot-f-YES | English 1 | 76 | Foot-f-YES | English 1 |
| 80 | Foot-g-NO | Related | 9 | Foot-ga-NO | Unrelated | 33 | Foot-g-NO | Unrelated | 22 | Foot-g-NO | Unrelated |
| 22 | Foot-p-NO | Related | 38 | Foot-p-NO | Related | 72 | Foot-p-NO | Related | 11 | Foot-p-NO | Related |
| 15 | Foot-t-YES | English 2 | 76 | Foot-t-YES | English 2 | 30 | Foot-t-YES | English 2 | 48 | Foot-t-YES | English 2 |
| 33 | Heart-d-NO | Related | 34 | Heart-d-NO | Related | 46 | Heart-d-NO | Related | 68 | Heart-d-NO | Related |
| 43 | Heart-h-YES | English 1 | 31 | Heart-h-YES | English 1 | 79 | Heart-h-YES | English 1 | 28 | Heart-h-YES | English 1 |
| 78 | Heart-t-YES | English 2 | 41 | Heart-t-YES | English 2 | 26 | Heart-t-YES | English 2 | 15 | Heart-t-YES | English 2 |
| 38 | Heart-w-NO | Unrelated | 54 | Heart-w-NO | Unrelated | 17 | Heart-w-NO | Unrelated | 49 | Heart-w-NO | Unrelated |
| 36 | Knife-ch-NO | Related | 40 | Knife-ch-NO | Related | 28 | Knife-ch-NO | Related | 44 | Knife-ch-NO | Related |
| 28 | Knife-f-YES | English 2 | 26 | Knife-f-YES | English 2 | 44 | Knife-f-YES | English 2 | 74 | Knife-f-YES | English 2 |
| 69 | Knife-n-YES | English 1 | 21 | Knife-n-YES | English 1 | 69 | Knife-n-YES | English 1 | 25 | Knife-n-YES | English 1 |
| 77 | Knife-w-NO | Unrelated | 28 | Knife-w-NO | Unrelated | 35 | Knife-w-NO | Unrelated | 19 | Knife-w-NO | Unrelated |

| Order A | | | Order B | | | Order C | | | Order D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* |
| 6 | Monkey-b-NO | Related | 32 | Monkey-b-NO | Related | 41 | Monkey-b-NO | Related | 71 | Monkey-b-NO | Related |
| 55 | Monkey-f-NO | Unrelated | 58 | Monkey-f-NO | Unrelated | 29 | Monkey-f-NO | Unrelated | 38 | Monkey-f-NO | Unrelated |
| 37 | Monkey-k-YES | English 2 | 48 | Monkey-k-YES | English 2 | 48 | Monkey-k-YES | English 2 | 8 | Monkey-k-YES | English 2 |
| 68 | Monkey-m-YES | English 1 | 6 | Monkey-m-YES | English 1 | 38 | Monkey-m-YES | English 1 | 55 | Monkey-m-YES | English 1 |
| 20 | Needle-d-YES | English 2 | 44 | Needle-d-YES | English 2 | 61 | Needle-d-YES | English 2 | 61 | Needle-d-YES | English 2 |
| 44 | Needle-n-YES | English 1 | 24 | Needle-n-YES | English 1 | 43 | Needle-n-YES | English 1 | 56 | Needle-n-YES | English 1 |
| 39 | Needle-s-NO | Related | 65 | Needle-s-NO | Related | 4 | Needle-s-NO | Related | 35 | Needle-s-NO | Related |
| 26 | Needle-v-NO | Unrelated | 49 | Needle-v-NO | Unrelated | 70 | Needle-v-NO | Unrelated | 9 | Needle-v-NO | Unrelated |
| 51 | Pillow-l-YES | English 2 | 53 | Pillow-l-YES | English 2 | 75 | Pillow-l-YES | English 2 | 6 | Pillow-l-YES | English 2 |
| 24 | Pillow-p-YES | English 1 | 35 | Pillow-p-YES | English 1 | 51 | Pillow-p-YES | English 1 | 62 | Pillow-p-YES | English 1 |
| 66 | Pillow-s-NO | Related | 67 | Pillow-s-NO | Related | 9 | Pillow-s-NO | Related | 23 | Pillow-s-NO | Related |
| 74 | Pillow-v-NO | Unrelated | 7 | Pillow-v-NO | Unrelated | 47 | Pillow-v-NO | Unrelated | 41 | Pillow-v-NO | Unrelated |
| 76 | Shirt-k-NO | Related | 57 | Shirt-k-NO | Related | 31 | Shirt-k-NO | Related | 16 | Shirt-k-NO | Related |
| 16 | Shirt-n-NO | Unrelated | 66 | Shirt-n-NO | Unrelated | 15 | Shirt-n-NO | Related | 31 | Shirt-n-NO | Unrelated |
| 12 | Shirt-sh-YES | English 1 | 18 | Shirt-sh-YES | English 1 | 65 | Shirt-sh-YES | English 1 | 51 | Shirt-sh-YES | English 1 |
| 2 | Shirt-t-YES | English 2 | 36 | Shirt-t-YES | English 2 | 64 | Shirt-t-YES | English 2 | 64 | Shirt-t-YES | English 2 |
| 63 | Spoon-ch-YES | Related | 1 | Spoon-ch-NO | Related | 40 | Spoon-ch-NO | Related | 53 | Spoon-ch-YES | Related |
| 70 | Spoon-d-NO | Unrelated | 75 | Spoon-d-NO | Unrelated | 52 | Spoon-d-NO | Unrelated | 7 | Spoon-d-NO | Unrelated |
| 75 | Spoon-n-YES | English 2 | 43 | Spoon-n-YES | English 2 | 6 | Spoon-n-YES | English 2 | 65 | Spoon-n-YES | English 2 |
| 9 | Spoon-s-YES | English 1 | 56 | Spoon-s-YES | English 1 | 66 | Spoon-s-YES | English 1 | 33 | Spoon-s-YES | English 1 |
| 7 | Watch-ch-YES | English 2 | 60 | Watch-ch-YES | English 2 | 12 | Watch-ch-YES | English 2 | 66 | Watch-ch-YES | English 2 |
| 62 | Watch-g-NO | Related | 45 | Watch-g-NO | Related | 39 | Watch-g-NO | Related | 18 | Watch-g-NO | Related |
| 48 | Watch-l-NO | Unrelated | 17 | Watch-l-NO | Unrelated | 78 | Watch-l-NO | Unrelated | 54 | Watch-l-NO | Unrelated |
| 57 | Watch-w-YES | English 1 | 68 | Watch-w-YES | English 1 | 1 | Watch-w-YES | English 1 | 24 | Watch-w-YES | English 1 |

| Order A | | | Order B | | | Order C | | | Order D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* | *Trial* | *Trial Name* | *Condition* |
| 11 | Well-k-NO | Related | 55 | Well-k-NO | Related | 77 | Well-k-NO | Related | 26 | Well-k-NO | Related |
| 25 | Well-l-YES | English 2 | 59 | Well-l-YES | English 2 | 62 | Well-l-YES | English 2 | 17 | Well-l-YES | English 2 |
| 67 | Well-t-NO | Unrelated | 39 | Well-t-NO | Unrelated | 13 | Well-t-NO | Unrelated | 63 | Well-t-NO | Unrelated |
| 79 | Well-w-YES | English 1 | 10 | Well-w-YES | English 1 | 54 | Well-w-YES | English 1 | 40 | Well-w-YES | English 1 |
| 45 | Window-b-NO | Related | 29 | Window-b-NO | Related | 5 | Window-b-NO | Related | 67 | Window-b-NO | Related |
| 30 | Window-d-YES | Unrelated | 51 | Window-d-YES | English 2 | 42 | Window-d-YES | English 2 | 27 | Window-d-YES | English 2 |
| 49 | Window-t-NO | Unrelated | 22 | Window-t-NO | Unrelated | 49 | Window-t-NO | Unrelated | 1 | Window-t-NO | Unrelated |
| 53 | Window-w-YES | English 1 | 3 | Window-w-YES | English 1 | 37 | Window-w-YES | English 1 | 50 | Window-w-YES | English 1 |

**Appendix 4: Word Ratings, MRC Psycholinguistic Database**

| Word | Age of Acquisition | Concreteness | Familiarity | Imageability | Brown verbal frequency | Kucera & Francis (1967) written frequency |
|---|---|---|---|---|---|---|
| Bird | 206 | 602 | 592 | 614 | | 31 |
| Bone | - | 588 | 541 | 567 | 2 | 33 |
| Candle | - | 565 | 544 | 594 | - | 18 |
| Cat | - | 615 | 582 | 617 | - | 23 |
| Curtains | - | - | - | - | 2 | - |
| Fish | - | 597 | 548 | 615 | - | 35 |
| Fist | - | | - | | - | 26 |
| Flower | - | 584 | 566 | 618 | - | 23 |
| Fly | - | 525 | 537 | 582 | 2 | 33 |
| Foot | - | 558 | 583 | 597 | 10 | 70 |
| Heart | 281 | 605 | 578 | 617 | 14 | 173 |
| Knife | - | 612 | 573 | 633 | 1 | 76 |
| Monkey | - | 566 | 531 | 588 | - | 9 |
| Needle | 264 | 608 | 533 | 589 | - | 15 |
| Pillow | 217 | 613 | 602 | 624 | 1 | 8 |
| Shirt | 269 | 616 | 612 | 612 | 5 | 27 |
| Spoon | 186 | 614 | 612 | 584 | - | 6 |
| Watch | - | 487 | 576 | 525 | 7 | 81 |
| Well | - | 467 | 550 | 522 | 1753 | 897 |
| Window | 231 | 609 | 621 | 602 | 4 | 119 |

## Appendix 5: Differentials

| Participant | Mean RT Related Condition | Mean RT Unrelated Condition | Differential |
|---|---|---|---|
| 1.00 | 1040.42 | 890.38 | -150.03 |
| 2.00 | 1079.31 | 982.92 | -96.38 |
| 3.00 | 1053.44 | 940.75 | -112.69 |
| 4.00 | 1152.53 | 1165.29 | 12.76 |
| 5.00 | 1285.56 | 1269.71 | -15.85 |
| 6.00 | 1353.67 | 1190.84 | -162.82 |
| 7.00 | 1261.77 | 1188.85 | -72.92 |
| 8.00 | 1400.10 | 1381.31 | -18.79 |
| 9.00 | 1202.43 | 1496.82 | 294.39 |
| 10.00 | 1664.50 | 1680.67 | 16.17 |
| 11.00 | 1468.33 | 1464.00 | -4.33 |
| 12.00 | 1351.00 | 1387.18 | 36.18 |
| 13.00 | 1650.00 | 1874.00 | 224.00 |
| 14.00 | 1168.22 | 1122.67 | -45.56 |
| 15.00 | 1110.44 | 1300.63 | 190.18 |
| 16.00 | 1432.00 | 1510.00 | 78.00 |
| 17.00 | 1172.58 | 1355.50 | 182.92 |
| 18.00 | 946.38 | 909.94 | -36.44 |
| 20.00 | 1231.13 | 1369.00 | 137.88 |
| 21.00 | 1366.00 | 1210.00 | -156.00 |
| 22.00 | 1580.00 | 1460.50 | -119.50 |
| 23.00 | 1788.20 | 1614.67 | -173.53 |
| 24.00 | 1414.00 | 1389.60 | -24.40 |
| 25.00 | 1356.77 | 1209.38 | -147.39 |
| 26.00 | 1333.00 | 1275.00 | -58.00 |
| 27.00 | 1330.10 | 1299.07 | -31.03 |
| 28.00 | 1737.00 | 1679.50 | -57.50 |
| 29.00 | 971.60 | 1131.63 | 160.03 |
| 30.00 | 992.00 | 1147.33 | 155.33 |
| 31.00 | 1313.75 | 1248.53 | -65.22 |
| 32.00 | 1736.71 | 1456.71 | -280.00 |
| 33.00 | 1110.80 | 1112.15 | 1.35 |
| 34.00 | 1215.19 | 1203.27 | -11.92 |
| 35.00 | 1318.71 | 1356.40 | 37.69 |

| Participant | Mean RT Related Condition | Mean RT Unrelated Condition | Differential |
|---|---|---|---|
| 36.00 | 1301.00 | 1170.17 | -130.83 |
| 37.00 | 1313.07 | 1385.07 | 72.00 |
| 38.00 | 949.77 | 966.63 | 16.86 |
| 39.00 | 1604.73 | 1410.55 | -194.19 |
| 40.00 | 968.80 | 944.21 | -24.59 |
| 41.00 | 1320.86 | 1250.21 | -70.64 |
| 42.00 | 1059.50 | 1189.07 | 129.57 |
| 43.00 | 993.86 | 1030.29 | 36.43 |
| 44.00 | 997.33 | 1094.53 | 97.20 |
| 45.00 | 946.00 | 986.79 | 40.79 |
| 46.00 | 1075.50 | 934.29 | -141.21 |
| 47.00 | 1159.71 | 1063.64 | -96.07 |
| 48.00 | 1240.54 | 1482.42 | 241.88 |
| 49.00 | 1490.75 | 1650.60 | 159.85 |
| 50.00 | 1577.08 | 1561.27 | -15.80 |
| 51.00 | 850.86 | 760.87 | -89.99 |
| 52.00 | 846.91 | 858.29 | 11.38 |
| 53.00 | 880.24 | 823.56 | -55.06 |
| 54.00 | 868.31 | 953.47 | 85.16 |
| 55.00 | 714.31 | 648.13 | -66.19 |
| 56.00 | 841.83 | 738.24 | -103.60 |
| 57.00 | 815.17 | 888.50 | 73.33 |
| 58.00 | 713.56 | 684.18 | -29.39 |
| 59.00 | 864.79 | 775.94 | -88.85 |
| 60.00 | 891.39 | 805.82 | -85.57 |
| 61.00 | 785.65 | 733.67 | -51.98 |
| 62.00 | 939.87 | 946.35 | 6.49 |
| 63.00 | 1115.61 | 938.47 | -177.14 |
| 64.00 | 938.39 | 1217.94 | 279.55 |
| 65.00 | 1542.85 | 1384.12 | -158.73 |

## Appendix 6: Phonetic Proximity

| Word Pairs | Related | Unrelated | Overlap in Voice/Place/Manner |
|---|---|---|---|
| PILLOW/sarhaanaa | voiceless alveolar fricative | voiced labiodental fricative | 1 |
| NEEDLE/sooee | voiceless alveolar fricative | voiced labiodental fricative | 1 |
| BONE/haddee | Voiceless glottal fricative | voiced alveolar lateral approximant | 0 |
| SHIRT/kameez | voiceless velar plosive | voiced alveolar nasal | 0 |
| WELL/khooh | voiceless velar plosive | voiceless alveolar plosive | 2 |
| FLOWER/phul | voiceless bilabial plosive | voiced alveolar plosive | 1 |
| WATCH/gharee | voiced velar plosive | voiced alveolar lateral approximant | 1 |
| SPOON/chamach | voiceless alveolar affricate | voiced alveolar plosive | 1 |
| BIRD/Chiree | voiceless alveolar affricate | voiced alveolar nasal | 1 |
| KNIFE/chhuree | voiceless alveolar affricate | voiced labial-velar approximant | 0 |
| HEART/dil | voiced alveolar plosive | voiced labial-velar approximant | 1 |
| CURTAIN/purdah | voiceless bilabial plosive | voiceless post-alveolar fricative | 1 |
| FOOT/puer | voiceless bilabial plosive | voiced velar plosive | 1 |
| CANDLE/mombattee | voiced bilabial nasal | voiced labial-velar approximant | 1 |
| MONKEY/Bandar | voiced bilabial plosive | voiceless labiodental fricative | 1 |
| WINDOW/baaree | voiced bilabial plosive | voiceless alveolar plosive | 1 |
| CAT/billee | voiced bilabial plosive | voiced labiodental fricative | 1 |
| FLY/makkh, makkee | voiced bilabial nasal | voiced labiodental fricative | 1 |
| FISH/mach, machee | voiced bilabial nasal | voiced alveolar lateral approximant | 1 |
| FIST/mutth | voiced bilabial nasal | voiced labial-velar approximant | 1 |